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Witness Statement No.7
ECONOMICS, ENVIRONMENTAL ASSESSMENT AND FOREST
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EA 87-02

IN THE MATTER of the Environmental Assessment Act (R.S.O. 1980, c.
140) as amended; and

IN THE MATTER of a hearing before the Environmental Assessment
Board regarding a Class Environmental Assessment for Timber
Management on Crown Lands in Ontario.

WITNESS STATEMENT No. 7

ECONOMICS, ENVIRONMENTAL ASSESSMENT
AND FOREST MANAGEMENT IN ONTARIO

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FILED ON BEHALF OF
FORESTS FOR TOMORROW
a coalition of

The Botany Conservation Group
of the University of Toronto

The Temiskaming Environmental
Action Committee

The Federation of Ontario
Naturalists

The Wildlands League, an Ontario
Chapter of the Canadian Parks
and Wilderness Society

The Sierra Club of Ontario

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ECONOMICS, ENVIRONMENTAL ASSESSMENT

AND FOREST MANAGEMENT IN ONTARIO

EXECUTIVE SUMMARY

1 Introduction

This witness statement provides analysis from an economic perspective for the position taken by Forests for Tomorrow at the Class Environmental Assessment of Timber Management on Crown Lands in Ontario. It considers whether forest management in Ontario meets the objectives of the Environmental Assessment Act. In particular, it considers whether the procedures laid out in the Class Environmental Assessment of Timber Management on Crown Lands in Ontario are likely to lead to the "betterment of the people...of Ontario by providing for the protection, conservation and wise management ... of the environment." (R.S.O. 1980, c.140,s.2). It also comments upon some of the testimony that has been introduced at the hearings by the Ontario Ministry of Natural Resources and by representatives of the forest industry.

2 Economic Analysis and Forest Management

Effective Forest Management requires a clear objective. Most applied economists recommend that forests and other assets be managed so as to yield the greatest possible net benefit to society. Net benefit is measured by the present value of the services provided by the forest less the costs of providing these services. This is often simply called the net present value (NPV) of the forest. This section of our statement

explains why the NPV objective is appropriate and why the procedures described in the Class EA prepared by the Ministry of Natural Resources are unlikely to achieve this objective.

2.1 An appropriate objective of forest management is to maximize the present value of services provided by the forest estate.

2.1.1 The forest estate yields a wide variety of services, both marketed and unmarketed.

2.1.2 Timber management alters the flow of forest services over time and hence alters the value received by the community from the forest estate.

2.1.3 Good timber management requires a clear objective (Baskerville, 1986)

2.1.4 In the context of forest management, applied economists would recommend the objective of maximizing the present value of the net social benefits flowing from the forest estate. (e.g. Bowes and Krutilla, 1989)

2.1.5 The net social benefit of forest services is normally measured by the amount people would be willing to pay for them (rather than to do

without them altogether) less the opportunity cost of providing them.

2.1.5.1 Willingness to Pay can be measured by the market value of goods under some circumstances but not others.

2.1.5.2 Similarly, the opportunity cost of providing forest services can be measured by the market value of inputs under some circumstances but not others.

2.1.5.3 The Net Social Benefit derived from the forest may be considered its contribution to National Income, properly measured.

2.1.6 The term "economic efficiency" refers to the degree that the present value of net social benefits has been maximized.

2.2 Maximization of the present value of net social benefits provided by the forest estate is compatible with the spirit of the Environmental Assessment Act and with the concept of sustainable development.

2.2.1 The concept of net social benefit makes

operational the stated purpose of the EA Act.

2.2.2 The procedures required by the EA Act are consistent with an attempt to maximize the net social benefit derived from an undertaking that affects the environment.

2.2.3 The concept of sustainable development requires can be imposed as a constraint in the calculation of net social benefits.

2.3 Economic activity that affects the environment should be regulated because unregulated private decisions will tend not to maximize net social benefit.

2.4 Certain objectives, such as community stability and equitable distribution of incomes, may not be reflected in simple measures of net social benefit; consequently care must be taken to include them in choosing among alternatives.

2.5 The EA process described in the Class Environmental Assessment prepared by the Ministry of Natural Resources is not likely to select timber management options which maximize the net social benefit derived from the forest estate.

- 2.5.1 The stated purpose of the undertaking is not operational and is not linked to its net social benefit.
- 2.5.2 The document does not provide for consideration of the full range of alternatives to the project and alternative methods of carrying out the undertaking at the Forest Management Unit level.
- 2.5.3 The document does not provide for a full and equal consideration of all uses of the forest.
- 2.5.4 No attempt is made to evaluate systematically the net social benefit of the undertaking and its alternatives.
- 2.5.5 A detailed critique of the Class EA document appears as Section 4 of this witness statement.

3 Assessment of Timber Management Practices in Ontario

This section reviews the economic issues associated with each of the constituent activities of timber management: land allocation, development of access, harvesting timber, regeneration, post-regeneration treatment, and protection. It considers current

procedures in Ontario and concludes that they fail to maximize the net social benefit that might be obtained from Ontario's forests.

3.1 Ontario's procedures for allocation of forest land in Ontario tend not to allocate land to its highest valued use because they are vague, discretionary, and biased towards timber production.

3.1.1 Forest land should be allocated to its highest valued use.

3.1.2 Efficient allocation requires an estimate of the value of forest land in various uses. Care must be taken to select a correct measure.

3.1.3 Existing procedures may be biased towards timber production because they ignore the costs incurred by non-timber users wishing to influence decisions.

3.1.4 Planning tools of varying sophistication are available to help allocate land.

3.1.5 The procedures for land allocation outlined in the Timber Management Planning Manual rely on non-

operational objectives and undirected judgement.

3.1.6 Current procedures do not adequately integrate timber and non-timber values.

3.1.7 The allocation of Forest reserves is not guided by a clear objective.

3.2 Procedures for the development of road access do not evaluate the net social benefit generated by the road. This may lead to uneconomic harvesting of forest land and increased environmental damage.

3.2.1 Subsidization of road costs may have led to harvesting areas beyond the extensive margin.

3.2.2 Ontario's procedures do not consider what road building standard will maximize benefits.

3.2.3 Ontario's procedures for scheduling road development do not appear to consider the net value of the resources accessed.

3.3 Ontario's procedures for determining whether to harvest, what harvest method to adopt, and what harvest schedule to follow are not related to maximization of the NPV of the

forest estate.

- 3.3.1 Harvesting procedures do not recognize that the presence of non-timber values can affect both the harvest schedule and the decision to cut at all.
- 3.3.2 The choice of harvesting system is biased towards clear cutting because environmental costs are not adequately considered and because silvicultural subsidies bias the choice of regeneration mechanism.
- 3.3.3 Ontario's procedures guarantee neither an even flow of wood nor maximized net social benefits.
- 3.3.4 Ontario's timber production targets do not favour maximization of the net present value of the forest because they are unrelated to the costs of production and silviculture.
- 3.4 Ontario's procedures governing regeneration are based on faulty economic reasoning and lead to excessive expenditures on artificial regeneration.
 - 3.4.1 The MNR's economic rationale for artificial regeneration is based on inappropriately high

estimates of the value of timber.

3.4.2 The choice of regeneration method is not based on NPV considerations and is biased against natural regeneration based on modified harvesting techniques.

3.5 Ontario's procedures governing the tending of regenerated forests are not based on the maximization of NPV and do not account in any way for the environmental costs of herbicides.

3.5.1 Procedures for determining whether treatment will be applied to NSR lands is not based on considerations of return to investment and appears to commit the fallacy of considering sunk costs.

3.5.2 The choice of treatment method appears to ignore potential environmental costs.

3.6 The procedures governing decisions to protect forests from fires and insects do not evaluate a sufficiently wide set of alternatives.

3.6.1 Although it is recognized that protection should be provided to high valued forests first, there is

no indication that protection has been demonstrated to increase the NPV of the forest.

- 3.6.2 Although the EA document calls for a comparison of the economic costs and benefits of protection, separation of the timber management and protection decisions bias the choice of protective method.

4 Assessment of the Class EA document

This section reviews the procedures proposed in the Class EA and concludes that they will not lead to "wise management" of the forest estate.

- 4.1 A section-by-section comparison of the EA document to the requirements of the EA Act reveals many specific weaknesses in meeting the requirements of the legislation.

- 4.1.1 The description of the purpose of the undertaking is not operational and is not linked to its net social benefit.

- 4.1.2 The descriptions of the undertaking, alternatives to the undertaking and alternative methods for carrying out the undertaking confuse the

provincial and forest management unit (FMU)
levels of analysis.

- 4.1.2.1 The document fails to make clear that the best alternative use of the forest may differ from FMU to FMU.
- 4.1.2.2 The document fails to examine a sufficiently wide set of alternative methods for supplying wood to the forest products industry in any particular FMU.
- 4.1.3 The rationale for the undertaking is based upon inappropriate data; no rationale is provided for alternatives to the undertaking and alternative methods for carrying out the undertaking.
- 4.1.4 The provision made for description of the environment affected is inadequate.
- 4.1.5 No standards are set for the DESCRIPTION OF ENVIRONMENTAL EFFECTS at the FMU level.
- 4.1.6 The description of PREVENTATIVE AND MITIGATIVE ACTIONS does not reflect the need to maximize the net benefits from all uses of the forest.

4.1.7 The EVALUATION OF ADVANTAGES AND DISADVANTAGES is inadequate.

4.1.7.1 It is not related to the Net Social Benefit of the undertaking.

4.1.7.2 It fails to evaluate alternatives at the FMU level.

4.1.7.3 It is inconsistent in its coverage of the forest industry.

4.1.7.4 The evaluation procedures described elsewhere in the document are also deficient.

4.2 In addition, the analysis in the Class EA reveals major conceptual weaknesses.

4.2.1 The Class Environmental Assessment document interprets the role of the Class Environmental Assessment in a manner inconsistent with the spirit of the Environmental Assessment Act .

4.2.2 The planning process described in the Class Environmental Assessment document fails to ensure

that all important alternatives, including the null alternative of not managing for timber supply, will be considered at the level of the forest management unit.

4.2.3 The Class Environmental Assessment document frequently ignores or underestimates the effect of timber management on non-timber activities.

4.2.4 The Class Environmental Assessment document generally fails to acknowledge difficulties created by the public goods nature of many forest services and the lack of bargaining power for certain groups.

4.2.5 The process described in the Class Environmental Assessment document pays insufficient attention to the contribution that can be made by the price system.

4.2.6 The economic analysis in the Class Environmental Assessment is minimal and faulty.

5 An Improved Planning Procedure

This section argues that effective multiple use management

of the forest estate requires a systematic evaluation of the costs and benefits of alternative forest management options. A simple case study of a hypothetical forest management unit demonstrates that such analysis is feasible and suggests that modified harvesting combined with natural regeneration may be the preferred management option in some circumstances.

5.1 The Nature of Cost-Benefit Analysis

Cost-Benefit Analysis is primarily a method of organizing information about an undertaking so as to guide the selection of the best alternative.

5.1.1 The steps in cost-benefit analysis include:

- (a) defining the project,
- (b) specifying alternatives,
- (c) predicting impacts,
- (d) valuing impacts.

These are essentially the same as required under the EA Act.

5.1.2 CBA usually assumes an objective of maximization of PV of net social benefit, but this is not necessary.

5.1.3 There is no one correct way to conduct a CBA;

rather there are a variety of approaches running from very simple to very sophisticated.

- 5.1.4 The informational costs of a sophisticated CBA may be very high.

5.2 Application of Cost-Benefit Analysis to Forest Management

- 5.2.1 CBA should be conducted approximately at the FMU level

- 5.2.1.1 The stand level is too small to accommodate all the interactions amongst users

- 5.2.1.2 The provincial level combines too many essentially independent problems.

- 5.2.1.3 Analysis at the FMU level must still account for important interactions at the provincial level, for example, the amount of wilderness recreational land remaining in the province.

- 5.2.2 A CBA should continually attempt to treat all uses of the forest - timber, recreational and non-participatory - on an equal footing.

- 5.2.3 Sophisticated CBA can be implemented using linear programming models such as FORPLAN, but this may be very expensive.

5.3 Example of a simple Cost-Benefit Analysis

This section demonstrates a simple cost-benefit study of the choice of silvicultural and harvest technique in a hypothetical Forest Management Unit. It shows that CBA at this level is entirely feasible and suggests that modified strip cutting may be preferred to clear cutting with artificial regeneration over a wide range of prices and discount rates.

- 5.3.1 The purpose of the example is to illustrate a practical method for conducting simple cost benefit studies, and to demonstrate that, under reasonable assumptions, modified cutting with enhanced natural regeneration may maximize the NPV of the forest.
- 5.3.2 The undertaking is to manage a hypothetical FMU for maximum net social benefit.
- 5.3.3 The alternatives to be considered are (A) management for non-timber values only, (B) modified cutting with enhanced

natural regeneration, (C) clear cutting with artificial regeneration, and (D) clear cutting with natural regeneration. Alternative (B) has two variants: B1 - a three-coupe system and B2 - a two coupe system.

5.3.4 In the base case, only alternative A (No Harvest) has positive net present value. The preferred ranking of the remaining alternatives is D (Clearcut/Natural Regeneration) (-\$43 million), C (Clearcut/Artificial Regeneration (-\$44 million), and B (Modified Cut Natural Regeneration) (-\$48 million).

5.3.5 Sensitivity Tests on Annualized Timber Benefits show the ranking of alternatives is sensitive to the social discount rate, the price of wood at the mill, the productivity of the site, and the allowable cut effect. All these tests assume a value of wood double the base case.

5.3.5.1 With \$50/m³ wood, natural regeneration is preferred for moderate social discount rates. Artificial regeneration is preferred only at very high or very low social discount rates. When the allowable cut effect (ACE)

is removed, artificial regeneration is preferred only at very low discount rates.

5.3.5.2 Natural regeneration is preferred when the value of wood is moderate or low. Given an allowable cut effect (ACE), artificial regeneration yields highest net timber benefits when the price of wood is high. This is not true when the ACE is removed.

5.3.5.3 Natural regeneration is desirable on sites of low to moderate natural productivity. Given an allowable cut effect (ACE), artificial regeneration yields higher net timber benefits on plots of high natural productivity (assuming the percentage increase in yields from intensive management is constant). This is not true if the ACE is removed.

5.3.6 The example leads to four conclusions:

5.3.6.1 Simple cost benefit analyses are entirely practical at the level of the forest management unit. They should be undertaken if only to ensure that all alternatives,

costs and benefits are considered during the preparation of a forest management plan.

5.3.6.2 Even when environmental factors are not considered, the choice of an appropriate silvicultural and harvesting system depends largely upon the price of wood at the mill, the discount rate, and the allowable cut effect.

5.3.6.3 Current values of wood are such that no harvest at all may well be the preferred option for some FMUs or some areas of some FMUs. In the absence of allowable cut effects, intensive management techniques such as planting and chemical tending can only be justified at unrealistically low rates of interest.

5.3.6.4 The allowable cut effect can make current artificial regeneration techniques attractive at high social discount rates. In these cases the value of second and subsequent harvests is negative.

At the EA hearings, evidence has been led concerning the contribution of the forest industry to the provincial economy and to community stability in Northern Ontario. This contribution is linked to the output and employment generated by the forest industries. This section comments on measures of contribution to the economy and their relationship to the objective of maximizing NPV. It also considers the probable development of the forest industry in light of forecasts of the demand for forest products and the cost of providing them.

- 6.1 Previous sections have demonstrated that cost benefit analysis can be successfully applied to evaluated alternatives at the FMU level. A similar analysis, based on net contribution to the economy rather than gross contribution, can be done at the provincial level.
- 6.2 Analysis of the net contribution of timber management suggests that it is having a net negative impact on the provincial economy of Ontario. A large net cost to the provincial government is not offset by industry revenue.
- 6.3 One justification for continued provincial government subsidization of timber management is its supposed contribution to regional development, and specifically, to stability of northern Ontario communities.

- 6.4 Forest industry activity may not contribute significantly to regional development.
- 6.5 Employment in the forest industries is cyclic, and the long term trends are stagnant or declining. The decline is particularly obvious when the number of people employed per unit of wood harvested is assessed.
- 6.6 The relatively high incomes in the forest industries are not an accurate reflection of the quality of life. The increase in wages over time has not kept pace with the increase in productivity. As a result, the contribution to community payrolls per unit volume of wood harvested has dropped.
- 6.7 A heavy dependence of northern communities on the forest industry detracts from community stability. There is no clear relationship between community stability and patterns of forest exploitation.
- 6.8 Community stability is more likely to be achieved by diversification away from forest industries.
- 6.9 A central part of Ontario's current timber management program is the Forest Production Policy. The policy is founded on faulty economic premises and is inadequate as a

basis for provincial forest use planning.

6.10 A thorough analysis of demand and supply at the provincial, national, and international levels for both timber and non-timber forest outputs is needed to anticipate the future demands on Ontario forests.

1. Introduction

This witness statement considers whether forest management in Ontario meets the objectives of the Environmental Assessment Act.

In particular, it considers whether the procedures laid out in the Class Environmental Assessment of Timber Management on Crown Lands in Ontario are likely to lead to the "betterment of the people...of Ontario by providing for the protection, conservation and wise management ... of the environment." (R.S.O. 1980, c.140,s.2). It also comments upon some of the testimony that has been introduced at the hearings by the Ontario Ministry of Natural Resources and by representatives of the forest industry.

We begin by examining the role of economic analysis in Forest Management. We stress that effective forest management requires a clear objective, and we propose that the general objective of forest management should be to maximize the net social benefit derived from the multiple uses of the forest estate. This constitutes Section 2 of our report.

Section 3 reviews economic issues associated with each of the constituent activities of timber management: land allocation, development of access, harvesting timber, regeneration, post-regeneration treatment, and protection. It considers current procedures in Ontario and concludes that they fail to maximize the net social benefit that might be obtained from Ontario's forests.

Section 4 reviews the procedures proposed in the Class EA and concludes that they will lead neither to "wise management" of the forest estate nor to the maximization of net social benefit.

Section 5 argues that effective multiple use management of the forest estate requires a systematic evaluation of the costs and benefits of alternative forest management options. A simple case study of a hypothetical forest management unit demonstrates that such analysis is feasible and suggests that modified harvesting combined with natural regeneration may be the preferred management option in some circumstances.

At the EA hearings, evidence has been led concerning the contribution of the forest industry to the provincial economy and to community stability in Northern Ontario. This contribution is linked to the output and employment generated by the forest industries. Section 6 of our report comments on measures of contribution to the economy and their relationship to the objective of maximizing NPV. It also considers the probable development of the forest industry in light of forecasts of the demand for forest products and the cost of providing them.

2. ECONOMIC ANALYSIS AND FOREST MANAGEMENT

Effective Forest Management requires a clear objective. Most

applied economists recommend that forests and other assets be managed to yield the greatest possible net benefit to society. Net benefit is measured by the present value of the services provided by the forest less the costs of providing these services. This is often simply called the net present value (NPV) of the forest.

This section of our statement defines the concept of NPV, explains why the NPV objective is appropriate and why the procedures described in the Class EA prepared by the Ministry of Natural Resources are unlikely to achieve this objective.

2.1. An appropriate objective of forest management is to maximize the net present value of services provided by the forest estate.

2.1.1. The forest estate yields a wide variety of services, both marketed and unmarketed.

Forest land, together with its standing timber, is an asset capable of yielding valuable products and services over a long, perhaps infinite, period. Some of these products are marketed through ordinary commercial channels. The most obvious example is the timber which is annually cut and processed into lumber or pulp and paper. Other products are fish and fur-bearing animals which can be harvested annually. In these cases the forests are

valued for the physical products they yield.

Forests provide other services which could be marketed, but are usually supplied at non-market prices. Chief among these are the use of forest land and related waters for recreation: fishing, hunting, hiking, canoeing and camping. Other services are even less marketable. Forests provide important ecological services in controlling drainage and in maintaining biological diversity (Forests For Tomorrow, Witness Statements 1A, 3, and 4).

Preservation of these services has been identified as a priority requirement for living resource conservation and sustainable development (IUCN, 1980). Some people derive pleasure from the existence of forests or the prospect of preserving them forever. Others view the preservation of forest land as an ethical or religious responsibility. Most of these services are related to the quantity and quality of forest land. (See Forests for Tomorrow, Witness Statement No. 4, for an extensive discussion of non-timber values of the forest.)

2.1.2. Timber management alters the flow of forest services over time and hence alters the value received by the community from the forest estate.

The products and services yielded by the forest can be affected by human intervention. For example, forest land can be allocated to timber production, recreational use, wilderness preservation

or a variety of multiple uses. Timber can be produced in forms suitable for lumber or for pulp and paper production. The yield of forest products and services over time can be affected by decisions concerning the rate of harvest, the manner of regeneration, protection and silviculture of the standing forest, and the construction of access roads. Thus expenditures on regeneration, silviculture, fire and pest protection, and access roads may be considered investments which may increase the flow of forest products and services in the future.

It is important to note that timber management will affect all of the services provided by the forest, including non-marketed recreational and ecological services. Hence timber management should not be considered in isolation from these other forest services.

2.1.3. Good timber management requires a clear objective.

Forest management is the task of controlling the flow of investments in the forest and the flow of products and services from the forest so as to meet or maximize some objective.

(Compare Baskerville, 1986, 94). In his audit of forest management in Ontario, Baskerville (1986) stressed that effective management must compare actual performance with measurable objectives. An objective whose achievement can be measured is said to be operational.

In Ontario, the objective of forest management is said to be the provision of "an optimum continuous contribution to the economy by the forest based-industry consistent with sound environmental practices and [the provision of] other uses of the forest" (OMNR, 1986e, p.1). Forest management on Crown Lands is subject to the Environmental Assessment Act of which the purpose is "the betterment of the people...of Ontario by providing for the protection, conservation and wise management...of the environment." As stated, these objectives are essentially non-operational. That is, one cannot tell how well they have been achieved because they are not measurable.

2.1.4. In the context of forest management, applied economists would recommend the objective of maximizing the present value of the net social benefits flowing from the forest estate.

While in principle one might specify almost any objective for forest management, most run into obvious difficulties. For example the objective of maximizing the volume of timber produced by the forest ignores the cost of producing the timber and the effect of timber production on the other forest services. A special branch of economics, welfare economics, has studied the problem of defining a social objective function that is consistent with the preferences of individuals. There are

serious problems in deriving a social objective that meets all reasonable criteria. Nevertheless, applied economists are virtually unanimous in recommending that an appropriate objective for public policy is the **maximization of the present value of net social benefits**. (Harberger, 1971; Boadway and Bruce, 1984; Bowes and Krutilla, 1989)

To understand this objective, recall that the forest yields outputs and uses inputs of various sorts at various times. The **benefit** of the outputs is some measure of their contribution to social welfare. Details are discussed in the next section. The **opportunity cost** of the inputs is contribution they would have made to social welfare in their best alternative use. The **net social benefit** yielded by the forest is the difference between the benefits and the opportunity costs.

Since costs are incurred and benefits are received at different times, some way must be found to compare them. Computing present values achieves this. The **present value** of a sum of money to be received in the future is amount of money which, invested today at a given interest rate, would yield principal and accumulated interest equal to the expected future amount. The **net present value** of the forest is the difference between the present value of the benefits and the present value of the opportunity costs, or equivalently the present value of the net social benefits.

This can be expressed concisely using symbols. Let B_t and C_t represent the benefits and costs of the forest in any year t . Then the net social benefit in year t is

$$NSB_t = B_t - C_t$$

and the net present value of the forest is

$$NPV = NSB_0 + NSB_1/(1+i) + NSB_2/(1+i)^2 + NSB_3/(1+i)^3 + \dots$$

where NSB_0 , NSB_1 , NSB_2 , ... denotes the NSB obtained this year, one year from now, two years from now, etc. and i denotes the social rate of discount.

The **social rate of discount** is the rate of interest used in the calculation. It should reflect the value of capital funds both to consumers and producers and should probably be at least 5% above the rate of inflation (Treasury Board, 1966; Burgess, 1981). Given the social rate of discount and the flow of net social benefits, the computation of NPV is exactly the same as used in standard business practice. (see Common, 183-188 and 269-72 for further details.)

2.1.5. The net social benefit of forest services is normally measured by the amount people individually or collectively would be willing to pay for them. The opportunity cost of forest services is the amount people would have been willing to pay for the goods and services that might otherwise have been produced by the inputs devoted to forest production.

Since the forest estate yields so many different services with such differing characteristics a way must be found to compare them, to add them together, and to compare them with the cost of achieving them. Applied economists do this by applying a monetary value to the services. In principle, the monetary value of a service is measured by willingness-to-pay (WTP). WTP for a service is the maximum amount people would be willing to pay to maintain the service rather than do without it altogether.

Using WTP as a measure of benefits does not imply that citizens should be charged individually for forest services. Willingness to pay for preservation of old growth forest, for example, might be ascertained by using a survey to estimate how much each citizen would be willing to increase his or her taxes to preserve the forest and adding the results together for the entire province.

The opportunity cost of achieving forest services is the value of

other goods and services society must give up because of the labour, capital and other inputs used to produce forest services. For example, standing timber can be sold and the proceeds used to construct roads and schools. The foregone services of these roads and schools are the true opportunity cost of the capital "tied up" in the standing timber.

As noted earlier, the net social benefit yielded by the forest estate is the difference between the WTP for the forest services and the opportunity cost of the inputs used.

2.1.5.1. Willingness to Pay can be measured by the market value of goods under some circumstances but not others.

Sometimes the market price of a good or service measures the social willingness to pay for one more unit of the good. For example, if the State of Florida were to give Canadians 1 tonne of oranges as a good will gesture, the benefit received might reasonably be estimated by the price Canadians would otherwise have had to spend to buy the oranges. This will only be true if the goods in question trade in reasonably competitive markets, if the increase in quantity is small, and if consumption and production of the good does not create external costs and benefits.

External costs are damages inflicted on third parties without

freely negotiated compensation. For example, cutting old growth timber in Temagami reduces the enjoyment felt by some environmentalists and canoeists, and building roads to remote areas reduces the value of wilderness recreation to some patrons of fly-in tourist camps. Conversely, **external benefits** are benefits conferred on third parties without negotiated payment. For example, construction of lumber roads may confer external benefits on motorized anglers and fishermen.

When important external costs and benefits are present, the market price of a commodity may not correctly measure society's willingness to pay for a service. For example, a lumber company's willingness to pay for a road may underestimate the value of that road if it simultaneously services recreational property.

Some forest services are not and perhaps cannot be sold in competitive markets. These may include hydrological and ecological services, spiritual renewal, wilderness recreation, and the existence of old growth timber. There may be a social willingness to pay for these items, but it cannot be expressed through any market.

2.1.5.2. Similarly, the opportunity cost of providing forest services can be measured by the observed costs of production under some circumstances but not others.

Observed costs of production reflect the costs of purchased inputs. When inputs such as labour exchange in competitive markets, the price paid for them reflects the value of output they could produce in other employment, and hence their opportunity costs. When there are important constraints on the mobility and pricing of inputs, the market price may be a poor estimate of opportunity cost. This is particularly important in labour markets. For example, if the forest industry in a community provides jobs with more stability and higher pay than other jobs available to the same workers, then wage costs will overstate the true opportunity cost of labour. In this case the measured cost of sawtimber or pulpwood would overestimate the true opportunity cost.

When production of a forest service creates external costs or benefits, the observed costs of production will not correctly reflect social opportunity costs. For example, if the production of sawtimber reduces the value of wilderness recreation the measured costs of production will understate the true opportunity costs.

Finally, when a private agent receives a subsidy or pays a tax

for the use of inputs, his or her observed costs will not correctly reflect social opportunity costs. For example, companies operating under Forest Management Agreements receive road building subsidies and free nursery stock from the province. Thus the cost of logging and planting observed by the companies is an underestimate of the true social opportunity cost.

2.1.5.3. The Net Social Benefit derived from the forest may be considered its contribution to National Income, properly measured.

If all the services provided by the forest were sold in undistorted competitive markets, and if all the inputs used in producing these services were purchased in undistorted competitive markets, and if a particular forest estate supplied only a small fraction of each relevant forest service, the Net Social Benefit derived from that particular forest estate would simply be the "profit" that a sole owner of that forest would derive from it after paying all costs. This "profit" would enter the national accounts as a contribution to net national income (roughly measured by GDP). Maximizing the NPV of the forest is like maximizing the forest's contribution to net national income after compensating for the fact that the conditions just specified are not met.

- 2.1.6. The term "economic efficiency" refers to the degree that the present value of net social benefits has been maximized.

Economists sometimes refer to the maximization of NPV as an efficient outcome and sometimes use the term "efficiency" to describe how close the economy has come to maximizing the NPV of social benefits. This definition is adopted in the present document. Note, however, that the term economic efficiency is also used in somewhat different ways within the discipline of economics.

- 2.2. Maximization of the present value of net social benefits provided by the forest estate is compatible with the spirit of the Environmental Assessment Act and with the concept of sustainable development.

- 2.2.1. The concept of net social benefit makes operational the stated purpose of the EA Act. (i.e. it provides a measurable objective to which achievement can be compared)

The stated purpose of the Environmental Assessment Act is ...the betterment of the people of the whole or any part of Ontario by providing for the protection, conservation and wise management in Ontario of the environment".

The act defines the environment very broadly as

- i. air, land or water,
- ii. plant and animal life, including man,
- iii. the social, economic and cultural conditions that influence the life of man or a community,
- iv. any building, structure, machine or other device or thing made by man.
- v. any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from the activities of man, or
- vi. any part or combination of the foregoing and the interrelationships between any two or more of them.

The Act may reasonably be construed as a recognition that the environment, broadly defined, is an asset which provides services to the human community, that this asset is affected by human activity, and that regulation can increase the benefits realized from the environment.

The Act seeks "the betterment" of the people of Ontario through

the "wise management" of the environment. To achieve this, one must make operational the concept of "betterment". We submit that seeking economic efficiency in order to maximize the present value of net social benefits may be equated to "wise management". The Environmental Assessment Act attempts to increase the economic efficiency of forest management by ensuring that the non-marketed recreational, environmental and ecological services flowing from the forest estate are fully integrated into forest management decisions. This interpretation of the EA Act provides a practical and quantifiable objective for forest management; a change in forest management will contribute to the "betterment of the people of Ontario" if it increases the NPV of forest services.

2.2.2. The procedures required by the EA Act are consistent with an attempt to maximize the net social benefit derived from an undertaking that affects the environment.

Section 5 of the Environmental Assessment Act requires that an environmental assessment consist of:

- (a) a description of the purpose of the undertaking;
- (b) a description of and a statement of the rationale for,
 - (i) the undertaking,
 - (ii) the alternative methods of carrying out the

undertaking, and

(iii) the alternatives to the undertaking;

(c) a description of,

(i) the environment that will be affected or that might reasonably be expected to be affected, directly or indirectly,

(ii) the effects that will be caused or that might reasonably be expected to be caused to the environment, and

(iii) the actions necessary or that may reasonably be expected to be necessary to prevent, change, mitigate or remedy the effects upon or the effects that might reasonably be expected upon the environment, by the undertaking, the alternative methods of carrying out the undertaking and the alternatives to the undertaking; and

(d) an evaluation of the advantages and disadvantages to the environment of the undertaking, the alternative methods of carrying out the undertaking and the alternatives to the undertaking. (R.S.O. 1980, c. 140, s.5).

As will be established below, these steps are almost identical to those required in a cost-benefit analysis. A cost-benefit analysis is a procedure designed to choose projects that yield the highest present value of net social benefits. Preparation for a cost-benefit analysis requires the steps laid out in section 5(c). The cost-benefit analysis proceeds by evaluating the advantages and disadvantages of a project by assessing their contribution to net social benefit. Thus maximization of NPV and associated techniques of cost benefit analysis provide a systematic way of fulfilling the requirements of section 5(d) of the EA Act.

2.2.3. The concept of sustainable development can be imposed as a constraint in the calculation of net social benefits.

In recent years considerable emphasis has been placed on the goal of "sustainable development". This term was defined by the UN World Commission on Environment and Development (Brundtland, 1987) as development "which meets the needs of the present without compromising the ability of future generations to meet their own needs" . The question is whether maximization of the present value of net social benefits is consistent with sustainable development.

Daly (1989, 19) argues that the Brundtland definition is not operational. (That is, we cannot measure how well we are achieving it). He distinguishes between growth ("expansion in the physical dimensions of an economic system") and development ("qualitative change ... of a physically non-growing economic system in a state of dynamic equilibrium maintained by its environment"). Sustainable growth would imply a continued increase in the flow of physical materials through the economic system. This is impossible. Consequently sustainable development must imply a constant rate of use of physical resources. Thus Daly implicitly defines sustainable development as a continued increase in the capacity to convert a "constant level of physical resource use into improved services for satisfying human wants".

The key requirement for sustainability is maintenance of the capital stock available for the production of goods and services. Daly and other advocates of sustainable development distinguish between natural and man-made capital. Natural capital provides the energy, raw materials and waste disposal capacity that are combined with labour and man-made capital to produce goods and services. The concept of "weak sustainability" requires that the sum of natural and man-made capital not diminish. The concept of "strong sustainability" requires that neither natural nor man-made capital, considered separately, be diminished.

In the context of forest management sustainability would seem to require (compare Daly, 1989, 34):

1. that the timber and other products of the forest be provided on a sustained yield basis: that is the volume produced should not decline when considered over a long time period, and
2. that irreversible loss of services, such as those generated by extinction of species or destruction of wilderness, be avoided.

Given these constraints, Daly recommends that renewable resources be managed on a "profit-maximizing basis", i.e. one which maximizes the NPV of the forest. Thus sustainability can be incorporated into forest management as a constraint which must be satisfied before net present value maximization is chosen.

2.3. Economic activity affecting the environment should be regulated because unregulated private decisions will tend not to maximize net social benefit.

Under certain conditions, a system of private ownership of forest land and private marketing of forest services would lead to an economically efficient outcome. When these conditions are not present, public management or public regulation of private management may be more efficient. Public regulation is not

necessarily more efficient; that depends on the details of the regulatory scheme. Forest production has many characteristics that may lead to market failure. Public regulation of forestry should be designed to correct these failures without creating others.

Markets fail to produce efficient outcomes when the prices being used by buyers and sellers do not correctly reflect social costs and benefits. There are three main sources of this failure:

- i. Some buyers or sellers may have the power to influence prices (market power).
- ii. Producing or consuming the service may generate external costs or benefits.
- iii. Taxes, subsidies or other incentives may distort private decisions.

The second of these categories is most relevant to environmental assessment, although all categories apply to the forest industry in Ontario.

Forest management generates external costs when the production of one output, say sawlogs, injures other users of the forest without compensation in the form of a freely accepted market

transaction. For example, construction of an access road into a previously inaccessible area may reduce its value to wilderness canoeists. This loss does not affect the profits of the logging company in any way. Consequently, the logging company has no incentive to minimize the damage done to wilderness canoeing.

Forest management generates external benefits when the production of one output benefits other users without compensation. For example, deer may thrive on the habitat created by logging, but private logging companies do not usually benefit financially from the improved hunting opportunities. Consequently they are likely to ignore the effects of their operations on wildlife habitat.

The most serious distortions of forest management occur because most non-timber uses of the forest are not sold through competitive markets. These non-timber uses are much broader than conventional recreation. They include the non-participatory uses of the forest for conservation of ecological variety, religious and social significance, etc., noted at the beginning of this section.

External costs and benefits are often generated by an inappropriate assignment of property rights. The right to wilderness recreation, for example, is not assigned to logging companies, nor is it assigned to wilderness canoeists. If loggers held the rights to wilderness recreation they could sell the

right to canoeists by reserving wilderness areas and charging admission. If canoeists held the right to certain wilderness reserves, logging companies could obtain the right to cut over the area only by paying a price which compensated the canoeists for their loss. The recreational use of the land would enter the logging companies' calculations either as a source of revenue (in the first case) or as a cost (in the second).

Even if property rights are assigned to identifiable agents, markets may fail to generate the correct price signals for many forest products. This is especially true when the products are public goods. Public goods, as defined by economists, have two important characteristics: joint supply and non-excludability. A good example is the existence of a wilderness area. Many in the community may derive pleasure from the existence of a remote wilderness, even if they never expect to visit it. This existence is jointly supplied to all members of the community, so that even if it is worth only a little to each individual, the community as a whole may be willing to pay a great deal to preserve it. But no individual can be excluded from enjoying the existence of the wilderness whether he or she pays for it or not. Accordingly each individual has an incentive to be a free rider, that is to minimize his or her own contribution while enjoying the wilderness that others pay for.

The importance of non-market forest services suggests strongly

that unregulated private forest management will be economically inefficient and that some form of public regulation or administration could be useful. We submit that it is the purpose of the Environmental Assessment Act to contribute to this regulation. An acceptable environmental assessment procedure must recognize the probability of market failure and its consequences.

2.4. Certain objectives, such as sustainability, community stability and equitable distribution of incomes, may not be reflected in simple measures of net social benefit; consequently care must be taken to include them in choosing among alternatives.

In discussions of forest management and similar undertakings, social goals other than economic efficiency are often mentioned. Prominent among these are the goals of promoting employment, the goal of community stability and the goal of sustained yield management. Sustained yield management may be viewed as good in itself (a component of sustainable development) or as a method of obtaining community stability.

In one sense, goals such as these are aspects of social well-being, and the degree to which they have been achieved should enter the social welfare function which is used to calculate net benefits. For example, people may be willing to pay a

significant sum to avoid the disruption of northern communities which would be caused by a sudden reduction in employment, and this might properly be counted as a benefit of improved community stability.

An alternative approach is to treat these objectives as constraints on the forest management projects we consider. For example, one might agree only to consider projects which lead to a roughly equal flow of timber every year. Normally imposing such constraints will reduce the measured net present value of the forest; that is, they imply a social cost. One can then calculate the cost of achieving a specified set of non-market benefits such as sustainability and community stability, and rely on some process of public consultation to determine whether the price is worth paying. For example, the maintenance of 50 jobs in an isolated community might imply sacrifice of measured net benefits with a present value of 50 million dollars, or 1 million dollars per job. Given this high cost, the province might investigate whether there were cheaper methods of achieving community stability or whether it would be better to close the community down and to fully compensate the residents.

It is essential not to lose sight of important social goals simply because they are not reflected in measurable market values. One must be careful, however, that the presumed goal is the real target. Increased employment, for example, is often

cited as the goal of many public programs. Yet closer examination may show that the real goal is either high paying, secure jobs or a reduction in the social costs generated by unemployment and low income. The benefit of the former can be measured by the excess of the high wage earnings over the alternative low wages while the benefit of the second may be measured by reduced expenditures on social agencies or collective willingness to pay for improved social conditions.

Similarly, many economists view community stability not as an end in itself, but as an attribute which may improve efficiency under some circumstances. Very few communities are completely stable in the sense of never growing or declining. Rapid changes in employment or income in a community, however, may impose financial and emotional costs on its inhabitants as they move in and out in search of employment. The social capital invested in schools, roads and housing may be underutilized if a community declines. Economic efficiency requires that these costs be included in the properly measured costs referred to earlier.

A frequently advocated goal of timber management is maximization of sustained yield. Economists criticize this goal on two grounds. First, it refers to physical rather than economic criteria. The rotation period which maximizes the sustainable flow of timber may be longer than the period which maximizes annual economic benefits. Secondly, constraining the annual

harvest to a level which may be maintained in perpetuity rules out a rapid harvest of the standing stock of timber. Such a rapid harvest is usually denigrated as "mining" the forest, but it may yield higher net benefits to society than a sustained yield policy. This is because the capital previously tied up in the forest could conceivably be better invested in other forms of social capital such as plant and equipment, roads, or an educated labour force. Such a policy might satisfy the constraint of "weak sustainability", discussed above, but not "strong sustainability".

To conclude, any computation of the net benefits of one project or management technique should exhibit as additional information indicators of the project's impact on variables of public interest for which no monetary equivalent is available.

2.5. The Timber Management Planning Process process described in the Class Environmental Assessment prepared by the Ministry of Natural Resources is not likely to select timber management options which maximize the net social benefit derived from the forest estate.

A detailed critique of the Class EA document appears as Section IV of this witness statement. The discussion of that chapter establishes the following conclusions:

The stated purpose of the undertaking is not operational (i.e. its achievement cannot be measured) and is not linked

to its net social benefit.

The document does not provide for consideration of the full range of alternatives to the project and alternative methods of carrying out the undertaking at the Forest Management Unit level.

The document does not provide for a full and equal consideration of all uses of the forest.

No attempt is made to evaluate systematically the net social benefit of the undertaking and its alternatives.

3. ASSESSMENT OF TIMBER MANAGEMENT PRACTICES IN ONTARIO

This section reviews the economic issues associated with each of the constituent activities of timber management: land allocation, development of access, harvesting timber, regeneration, post-regeneration treatment, and protection. It considers current procedures in Ontario and concludes that they fail to maximize the net social benefit that might be obtained from Ontario's forests.

3.1. Ontario's procedures for allocation of forest land in Ontario tend not to allocate land to its highest valued use because they are vague, discretionary, and biased towards timber production.

Land allocation decisions are potentially the most important in terms of the environmental impacts of forest management. They are closely tied to decisions about the development of access and the location of timber harvesting. Land allocation decisions

determine the land base on which timber harvesting may be conducted.

In some cases, notably the allocation of wilderness areas to other purposes, the decision is an irreversible one (Krutilla and Fisher, 1985). Technological change cannot increase the availability of wilderness areas. This contrasts with the impact of increased timber prices on the proportion of land that can be profitably logged. In the face of uncertainty about future relative prices of the various uses of wilderness areas, the decision to devote a wilderness area to another use, such as timber harvesting, should be made very reluctantly. The same concerns exist for reserves that are set up to preserve particular threatened species, ecological processes or valuable genetic material.

3.1.1. Forest land should be allocated to its highest valued use.

The key issues in land allocation are whether an area of forested land should be developed, and, in particular, whether it should be allocated to timber production? The criterion of economic efficiency:

...implies that land areas should be devoted to the uses, forest or non-forest, that yield the greatest potential economic benefits - whether or not those benefits are reflected in market transactions. (Repetto, 1988, p.2).

Note that in some cases a judiciously chosen mixture of uses may have a higher value than any single use.

3.1.2. **Efficient allocation requires an estimate of the value of forest land in various uses. Care must be taken to select a correct measure.**

Obviously one of the requirements to determine the appropriate allocation is accurate information about the values associated with particular land uses and about the interaction among these uses. This is more difficult when particular values are not marketed. It is also more difficult when some values are unknown, as for example in the case of wildlife populations. Thompson (1988) suggests that for furbearing animals in Ontario the problem is that "...none of the species in question has become rare enough to warrant an expensive research program." (p.259). Ignorance of the values of competing non-timber uses of the land does not necessarily prevent decisions. In some cases, a simple inequality may suffice to allocate land (Hyde, 1980).

Placing an economic dimension on the forest inventory and on the land base is essential to planning the most economically efficient land use. This kind of analysis has been applied in British Columbia to take explicit account of economic variables affecting delivered wood costs and timber values and thereby to

identify the economic land base (Morrison et al., 1985; Williams and Gasson, 1986; Williams, 1987).

In principle, the value of land used for timber production should be derived from the value of wood on the stump. This may be estimated by deducting logging and transportation costs from the price mills are willing to pay for delivered wood.

Some estimates of the economic dimensions of forested land have mistakenly been made on the basis of the value of shipments of wood products (e.g. Jones, 1987). As a similar example of this kind of erroneous approach, Oppen (1988) estimated the value of a reserve around an osprey nest based on the price of pulp, rather than on the basis of the net value of the timber. This estimate implies that other inputs used in producing wood pulp would have been idle had they not been used in processing wood from this reserve. A better estimate of the cost of the osprey nest would be the **reduction** in measured national income (e.g. in profits, labour earnings, and tax collections) that is caused by imposing the reserve. If alternative sources of wood are available, this reduction may be very small, even in the short run. In the long run, when capital and labour have a chance to adapt their plans to changes in future wood supplies, the reduction may be almost zero.

3.1.3. Existing procedures may be biased towards timber

production because they ignore the costs incurred by non-timber users wishing to influence decisions.

It is not economically desirable to harvest wood from every square metre of land. Some areas make a greater contribution to social welfare allocated to bird habitat or recreational areas than as industrial forest. Economically efficient allocation of land will also recognize that the joint production of goods and services from the same parcel of land may be preferred to allocation to a single use.

Attempts to integrate multiple uses of forest land have often led to conflicts between users, as users identify with land uses. For example, there has been tendency on the part of foresters to assume that the lowest value land use is forestry, hence the land is theirs by default. Fahlgren (1985) has argued that "...the burden of proof that an area should not be designated [as a forest protection area] ought to be shifted to the forest products industry." (p.5-19). Any use of the land must first be justified in comparison to the no-development alternative.

Resistance from traditional users of the forest to consideration of non-timber and non-market values may inhibit efficient allocation of land. The Environmental Council of Alberta (1979) noted the following reactions from the party who bears the costs:

1. He [sic] may exaggerate the cost. This is natural since any cost that does not bring some benefit to him is felt far more acutely than a cost that is at least partially covered by received benefits.
2. He may denigrate the benefit. Since he does not receive them, they tend to be ethereal and insubstantial in his view.
3. He may tend to insist that more costly practices bring no more benefits than least-cost practices.
4. He may tend to insist on strict accounting practices - his costs are real and precise. He will wish to have an equally accurate accounting of the benefits. (p.63).

The conflicts between logging and some other users of the forest have led to extended political battles over land use. In general, other forest users are not compensated for the costs imposed on them by logging.

If particular groups are necessary to identify resource values, especially non-market values, they must be involved in this planning procedure. For groups or interests that are not regularly included in the procedure (e.g. groups outside of the MNR or the logging industry) there is a cost to participating in

land use decisions. This cost introduces a bias against non-timber and non-market values because the value to the individual or group of the particular land use must exceed the cost of participating in the decision before those other values will be included. This bias is particularly evident when values such as existence, bequest, and option values are involved.

For political reasons or because of a lack of unbiased information, it may be necessary to approximate an economically efficient decision through public consultation or hearing. Fox (1985) has suggested three guidelines for this hearing procedure: no individual resource should have preferred status, all parties should be able to participate equally, and the proceedings should not be manipulable by a single group. He goes on to note that

...unless the processes of integration are guided by an individual who is widely regarded as fair and impartial, and unless those participants with relatively limited professional resources at their disposal are supplied with such assistance, effective integration cannot be expected to occur for those areas in which it is most needed. (p.142).

3.1.4. Planning tools of varying sophistication are available to help allocate land.

Cost Analysis

Environmental considerations are sometimes distinguished from economic issues in allocating forested land. Yet in many cases, areas removed from the timber production land base for environmental reasons may simply be uneconomic to harvest. For example, areas in British Columbia with steep slopes and

sensitive soils are removed from the land base for timber production. This removal is equivalent to removing the land because the costs of logging on these slopes with the associated landslides (and resulting impacts on fish habitat and aesthetic values, for example) exceed the timber values. Removing such areas from the timber producing land base is simply an attempt to internalize the expected (large) costs of logging on such slopes.

Zoning

One of the simplest approaches to land allocation is to delineate zones based on guidelines or rules of thumb. Such zones should be viewed as a first approximation to an explicit analysis of the economic values concerned. They may suffice to protect certain resources or uses of the forest, but in the absence of economic information, there is no common "currency" (literally) to compare resource values or to evaluate the guidelines.

Extensive and Intensive Margins

One way of simplifying the land allocation decision is to identify the intensive and extensive margins for a particular land use. The **extensive margin** is the geographic point beyond which the return from cultivation does not cover the costs of the labour and capital used. (Compare Ise, 1946, p.440). This concept has some practical utility for forest management because many uses of forested land in North America produce relatively low values per unit area and costs tend to increase with

distance. As a result, the extensive margin can be located geographically. Social costs occur when a particular use (e.g. logging) occurs beyond the extensive margin. Subsidization of logging or road building costs can cause this to occur.

The **intensive margin**, in contrast, identifies the best technique for cultivating a particular area. Silvicultural techniques, for example, range from natural regeneration which involves a minimum of labour and capital to very intensive methods of site preparation, planting, tending and fertilizing. These latter methods use a great deal of capital and labour and are very expensive as a result. The intensive margin is the most intensive silvicultural technique which will repay the extra investment of labour and capital. Beyond the intensive margin, further silvicultural investments earn too low a rate of return to justify the extra capital and labour used. The location of the intensive margin depends on the prices of forest outputs and the costs of inputs (including environmental ones). Subsidization of silvicultural expenses can result in the application of labour and capital beyond the intensive margin.

Consideration of Alternatives

An array of quite sophisticated techniques and tools have been applied to the problem of allocation of forested land. For example, in British Columbia, Options Reports are prepared for each Timber Supply Area (e.g. British Columbia Ministry of

Forests, 1986). These Options Reports lay out a set of options such as intensified forest management, improved timber utilization, and exclusions of land from the timber land base. The implications of each option is presented in terms of such variables as timber supply and employment.

Linear Programming

One of the chief planning tools for land allocation in the National Forests in the United States is the large linear programming model, FORPLAN (described in Joyce et al., 1983). This model can solve land allocation problems, management activity scheduling problems, and output mix problems. It explicitly includes the other forest resources besides timber.

3.1.5. The procedures for land allocation outlined in the Timber Management Planning Manual rely on non-operational objectives and undirected judgement.

The Timber Management Planning Manual (OMNR, 1986e) provides a detailed description of the land allocation procedure within a forest management unit. The procedure begins with a review of "...all objectives and targets which have been established and assigned by higher levels of planning..." (p.7). "This review will determine what objectives will govern operations and the extent of the contribution expected from the units or forests to the assigned district targets." (p.7). There appears to be

considerable latitude with respect to adherence to specific objectives. This will lead to sub-optimal decisions if the decision-makers do not have responsibility for maximizing social benefits.

The next step is the allocation of land to particular activities. The criteria are quite vague:

Allocation for depletion is based on considerations such as age, quality, proximity to access, or the need for salvage. Allocation for renewal is based on management strategies, the possibility of natural regeneration, site protection, etc. Allocation for maintenance is based on the values to be protected. The expected return on investment should be considered for all renewal and maintenance operations. (OMNR, 1986e, p.11).

Within the areas eligible for allocation, areas of concern are identified by incorporating "...input from other MNR programs represented on the planning team and from other government ministries, interest groups, and the public..." (p.11) and "[i]nformation contained in the District Land Use Guidelines (DLUG)..."(p.11). Areas of concern are defined as those areas which are "...deemed to be of value to other users which could be affected by timber operations, including the provision of access, and which may require modifications to operations." (p.11).

Once areas of concern have been identified:

...specific areas must be selected on which operations will take place during the five-year term of the plan. The total area to be allocated should be consistent with the required levels of depletion, renewal and maintenance as previously determined. (OMNR, 1986e, p.12).

Thus the levels of forest management operations are externally determined and do not reflect economic factors at the particular sites.

Harvest locations are selected by using a set of criteria specific to the management unit. No criteria are required to be used; the choice of criteria, and hence the choice of stands, appears to be at the discretion of the forester. Areas are chosen up to the level of the MAD, although not all of this land may be available for harvest if, for example, areas of concern are removed. Not all of this land may be economic to harvest.

Within areas of concern, the so-called "comprehensive planning process" is carried out. In this process, two determinations are made. First, whether timber management operations can be carried out "...while protecting the other identified resource features, land uses or values" (OMNR, 1987b). If they cannot be carried out given this constraint, then the land is included in a forest reserve (see below). If they can be carried out, then the second decision is how to conduct them.

If...normal operations cannot be conducted without a detrimental effect, it must be determined if operations can be modified so as to still contribute to the achievement of the forest management objective while not negatively impacting on another program's

requirements for the same area. (p.12, emphasis added).

For the first determination of whether timber management can be carried out, no criteria are specified. There is no indication of how the boundaries of areas of concern are determined. There are no criteria for evaluating the mix of plans that may result from integrating objectives. By restricting consideration to other programs, only a biased subset of values will be evaluated.

Modified operations in areas of concern require further planning steps as part of the comprehensive planning procedure. (These steps are virtually identical for planning access roads in areas of concern and so will be considered in more detail.)

In the development of these specific prescriptions; 1) alternatives must be considered, 2) a comprehensive evaluation and comparison of the potential environmental effects of the alternatives is required, and 3) the preferred or most acceptable prescription is selected. (p.13).

Only one prescription need be considered (OMNR, 1987b). Thus a comparison with the no-development alternative is not required. The criteria for a "comprehensive evaluation" are not given. Thus it is unlikely that the proper decision will be made.

The analysis of environmental effects involves the following

three steps:

- i. identification of the potential environmental effects;
- ii. determination of the significance of those effects; and
- iii. identification of the potential preventive and mitigative measures. (p.3 (Appendix I), OMNR, 1987b)

The effects are turned into impacts "...by incorporating value judgements" (p.3 (Appendix I), OMNR, 1987b). Finally, the selection of the preferred or most acceptable management prescription is "...invariably based upon judgement." (p.5 (Appendix I), OMNR, 1987b). These statements provide no guidance about the central issue, the choice of timber management prescription. Unless the objectives of management are specified, application of judgement will be entirely arbitrary.

3.1.6. Current procedures do not adequately integrate timber and non-timber values.

Another key fault of the current timber management planning in Ontario is its lack of integration with non-timber values. The Timber Management Planning Manual (OMNR, 1986e) discusses the role of non-timber objectives in the following way:

While the [timber] production objective can be quantitatively stated, the remainder of the forest management program objective can only be defined in qualitative terms. The objectives that all operations be carried out using sound environmental practices and that other uses of the forest resources be provided for are oriented to the process of meeting the production objective and generally define limits on the methods which may be

employed to achieve that objective. (p.5).

Baskerville (1986) concludes that "...the approach used in OMNR planning is not achieving an optimum with respect to all values obtained from the forest." (p.73) and that:

The isolation of timber management planning from these other concerns means that the other values can only enter the timber decisions, which are the only real control in forest structure over time, as constraints. They are not in fact part of a central objective (p.74).

The provision for other uses of the forest is accomplished by so-called "integrated resource management". Integrated Resource Management in Ontario is defined as "...the coordination of resource management programs and activities so that long-term benefits are optimized and conflict between programs are minimized." (Policy and Planning Secretariat, 1986, p.37). This same document goes on to note that "(Benefits are defined by corporately-approved program targets and by District Land Use Guidelines.)" (p.37). Thus any benefits or land uses which do not fall into one of these categories will not be "integrated" into the decision-making.

3.1.7. The allocation of forest reserves is not guided by a clear objective.

The procedure of establishing forest reserves in Ontario began "...after a number of lakes supporting populations of speckled trout (Salvelinus fontinalis) were reportedly ruined by improper

logging practices during the 1950s." (Puttock, 1985).

There appear to be only two attempts to evaluate the costs of forest reserves in Ontario. In the first, Puttock (1985) made rough estimates for an area to be harvested by Great Lakes Forest Products. The increased costs to the company were the result of planning and layout of reserves (\$6.76/ha) and of increased road construction costs (\$12.63/ha). The increased costs to the provincial Crown were in the form of foregone stumpage revenue. Puttock's analysis is inadequate on at least three counts. First, he ignores the fact that access development and harvest schedules will (or should) change with changes in the distribution of wood to be harvested. Second, he ignores possible differences in the value of the wood harvested in reserved and non-reserved areas, i.e. he only considers cost rather than net value. Third, the increases in non-timber benefits (e.g. tourism) caused by a reserve should be considered alongside the cost in timber benefits foregone.

In the second case study, presented in Panel 2 of the industry evidence, an attempt was made to evaluate the economic impact of establishing forest reserves based on an application of the guidelines prepared by the OMNR. Existing forest reserves were estimated to increase wood costs by \$0.67 per cubic metre (about 1.5%). A vaguely defined "inflexible reserve" scenario was estimated to add an additional \$1.00 per cubic metre to wood

costs.

Several criticisms of this case study were developed in cross-examination. It is unlikely that the results from this case study can be extrapolated to other areas of the province. In addition, this case study ignores any benefits which would result from establishing the reserves, and is thus only a partial economic impact analysis. Given the relatively small change in wood costs, it would not require a large increase in the benefits to offset the calculated loss.

Forest reserves may be established as a result of applying the timber management guidelines for tourism, moose, and fish. The level of understanding of the environmental effects of timber management in Ontario is clearly inadequate to justify these guidelines. A recent review (McNamee et al., 1987) of the guidelines identified 36 potential environmental effects of timber management. The significance of the effect was uncertain in 19 out of the 36 cases. The current guidelines dealt with only 22 out of the 36 possible effects. Of these the significance of the effect was unknown for 12 (55%) of the potential impacts.

This lack of understanding is exacerbated by the increasing role of the FMA holders in managing the land base; they do not have a mandate for or a background in the other resources such as wildlife. "The companies do not maintain technical skills in the

non-timber area, and have no contractual obligations other than to accept the OMNR modifications to timber management plans." (Baskerville, 1986, p.63).

Forest resources, timber and non-timber, are integrated in Ontario by personal decisions, and sometimes through negotiation with other interested parties. "However, because these are independent, site-specific decisions they will not be optimal in any rigorous sense for the Unit nor for the Province."

(Baskerville, 1986, p.12). The assumption is made that this process "...recognizes and considers all interests in the planning area that might overlap with timber management." (OMNR, 1986e, p.2). This consideration is likely to be superficial and arbitrary, given that the non-market values have not been quantified.

In summary, the criteria for land allocation are very poorly defined, there is considerable discretion, and there is no requirement for the decision-maker to maximize social benefits by properly incorporating non-timber and non-market values. The result is a crude zoning system biased toward timber production.

3.2. Procedures for developing road access do not evaluate the net social benefit generated by the road. This may lead to uneconomic harvesting of forest land and increased environmental damage.

Road construction in Ontario has (necessarily) expanded with the increasing harvest from Crown land (OMNR, 1986b). Through a number of programs, notably the FMAs, the MNR reimburses companies for building or maintaining roads at rates negotiated in the Agreements. Under the FMAs the company is responsible for carrying out the work and the MNR is responsible for paying for (most(?) of) it. In 1986-87, companies constructed or reconstructed 1,468.3 kilometres at an average cost to the MNR of \$22.5 thousand per kilometre. They also maintained 3,621.4 kilometres at an average cost to the MNR of \$492 per kilometre (OMNR, 1987d). In the MNR's response to the Office of the Provincial Auditor (1986), it is stated that, unless otherwise specified, FMA holders are responsible for maintenance over the lifespan of the road and are only eligible for a small subsidy per kilometre from the Ministry.

3.2.1. Subsidization of road costs may have led to harvesting areas beyond the extensive margin.

An area should be accessed if there is a net social benefit. From the perspective of a timber company, this usually means: does the reduction in transportation costs spread over the timber to be harvested exceed the costs of construction and maintenance? Because roads represent major investments and may have substantial external costs and benefits associated with them,

this simple financial test is not sufficient; it is essential to account properly for additional benefits and costs over the time span of effects from the road and over the total area affected. The cost-benefit analysis should examine the alternatives, including the opportunity costs of land, capital, and other inputs.

This issue has been particularly important in the United States with the controversy over so-called "below-cost" timber sales. Various groups have charged the Forest Service with selling timber at a price below the cost of production (including building the access roads). Repetto (1988) cites four studies which document the failure of the United States Forest Service to pass this basic financial test. The concern is that irreversible environmental degradation may occur without any economic justification. Bowes and Krutilla (1989) demonstrate that below-cost timber sales should be undertaken only if they are the least cost way of increasing certain non-timber benefits.

Provincial governments in Canada have built roads to encourage the growth of the timber-based industries. The justification has often been that the province has a responsibility as a landlord to maintain and enhance the transportation infrastructure. For example, until recently, timber harvesting companies in British Columbia could claim road construction costs against their stumpage fees. The argument that the provincial Crown as

landlord has a responsibility to provide and maintain roads for timber harvesting may be criticized on two grounds: (i) that the Crown may not be charging enough rent (stumpage) to cover the costs of road-building, and (ii) the Crown is also a landlord to other resource users, some of whom may suffer from the construction of roads.

These subsidies increase the harvest rate and spread it over a larger area with the consequent environmental impacts. If the stands that are accessed are beyond the extensive margin, then there is a social cost to building roads.

The Timber Management Planning Manual (OMNR, 1986e) summarized the procedure for selecting locations of roads in Ontario as follows:

The locations of broad corridors (up to one kilometre wide) must be determined for all primary roads required to access the areas which are eligible for allocation during the twenty-year period of the plan. Alternative locations for the broad corridors must be identified. The alternative corridors are then analyzed according to three criteria which measure the effectiveness of:

- access to areas eligible for harvest, renewal, and maintenance;
- accommodation of preliminary areas of concern; and
- cost of construction, maintenance, hauling, etc.

The analysis of the alternative corridors will lead to the selection of a preferred or most acceptable location.
(p.14).

There does not appear to be any procedure to evaluate the

benefits, let alone the net benefits, of building a road to access forested land.

Elsewhere (OMNR, 1987b), there is a recognition that "...the level of capital investment required to conduct an operation (e.g. to construct new access roads)..." (p.139-140) ought to be one of the factors to be considered in developing the criteria used to select forest stands for harvesting. The concern appears to be only for cost-effectiveness, e.g. accessing X hectares at a cost of only Y dollars. Thus it seems that proposed access roads are not required to pass even a simple financial viability test, despite the expenditure of over \$40 million in 1986-87 on road construction. The negotiated subsidies may result in excessive and inequitable distributions of funds (Office of the Provincial Auditor, 1986).

3.2.2. Ontario's procedures do not consider what road building standard will maximize benefits.

The choice of road standard or class for a road built for timber harvesting will depend on the value of the timber accessed, the effect of road standard on costs, and the timing of the harvest schedule. It will also depend on the future use of the land and an accounting for other uses of the forest.

This question does not appear to be properly addressed in

Ontario. "The process of planning of access construction varies depending on the class of road being planned." (p.14, OMNR, 1986e), although there is no indication of how. The Office of the Provincial Auditor (1986) noted a lack of consideration for future use of the roads, one of the factors which should influence the choice of road standard.

3.2.3. Ontario's procedures for scheduling road development do not appear to consider the net value of the resources accessed.

Obviously planning a road network should be closely integrated with timber harvesting and with other uses of the forest.

This requires planning an access schedule at the level of a management unit over at least a rotation period. The timing of access development is a problem that should take into account timber supplies to mills, construction costs, maintenance costs, the time necessary to harvest accessed timber, and the net value changes of all the resources on accessed land. As above, the goal is to maximize the net social benefits over the unit and over time.

This issue does not appear to be systematically addressed in Ontario. Funds for road building are apparently allocated among regions according to a weighting scheme based on past harvests,

past road building, and funding over the last five years (Office of the Provincial Auditor, 1986). Net values of resources accessed do not appear to enter the calculations.

3.3. Ontario's procedures for determining whether to harvest, what harvest method to adopt, and what harvest schedule to follow are not related to maximization of the NPV of the forest estate.

Timber harvesting is a highly dispersed activity, but in aggregate it constitutes the greatest human intervention into the dynamics of forest ecosystems. For example, the area of Crown land harvested in Ontario in 1986 (190,306 ha) was greater than the area burned in the same year (143,243 ha) (Smyth and Campbell, 1987). The volume of softwood harvested from Crown lands in 1981 (16.3 million m^3) was greater than the average estimated insect losses between 1977 and 1981 (15.5 million m^3) (Smyth and Campbell, 1987).

The major ecological impacts of logging may alter the magnitude of and implicitly impose a schedule on the flow of other goods and services from forest such as wildlife populations (e.g. Baskerville, 1985; Patch, 1987). Thus harvesting decisions are also decisions about the diversity of wildlife habitat and the size and species composition of bird communities.

The harvest of timber in Ontario varies with the business cycle, but there is a long-term increasing trend. The softwood harvest in 1986 (15.8 million m³) was up 96% from the figure in 1976 (8.0 million m³). The hardwood harvest in 1986 (3.8 million m³) increased 212% over the 1976 figure (1.2 million m³) (Smyth and Campbell, 1987). The actual volumes cut are determined by market requirements of the firms receiving the wood.

3.3.1. Harvesting procedures do not recognize that the presence of non-timber values can affect both the harvest schedule and the decision whether to cut at all.

The decision to cut a stand depends on an evaluation of the net value of harvesting. Because in general stands increase in value as the trees grow, economists have also addressed the question of whether a stand should be cut by calculating the age at which it should be cut. If the stand is older than the optimum age it should be cut; if not, it should be left. Using this kind of approach, Hartman (1976) analyzed the case where a forest produced "recreational services" that were related to the size of the standing crop. Depending on the relative magnitude of the "recreational services", no harvest could be the economically optimal choice. Heaps (1985) obtained a similar result. Calish et al. (1978) also investigated the effect of incorporating different non-timber values on the choice of rotation age; some

non-timber values (e.g. provision of browse) reduce the optimum rotation period, others increase it.

The selection of stands for harvest in Ontario is not based on any systematic economic analysis, nor does it necessarily include consideration of non-timber values, beyond those accounted for in the areas of concern.

The MNR argues in the Class Environmental Assessment document (OMNR, 1987b) that harvesting produces significant benefits:

The direct economic benefits of harvest operations are the provision of wood for the market and the employment generated. Both of these have indirect and multiplier effects on the local, regional and provincial economy. (p.82).

As discussed above, these variables are inappropriate measures of net economic benefits.

3.3.2. The choice of harvesting system is biased towards large area clearcutting because environmental costs are not adequately considered and because silvicultural subsidies bias the choice of regeneration methods.

Clearcutting methods tend to be cheaper given the harvesting technology currently used, but also tend to have the most deleterious environmental impacts. As a result of concern over the potential environmental damage of clearcutting methods, the United States has established relatively precise and restrictive

guidelines for the use of clearcutting (Church Guidelines for Federal Lands 1972, cited in Weetman, 1983):

2. Harvesting limitations

Clear-cutting should not be used as a cutting method on Federal land areas where:

- a. Soil, slope or other watershed conditions are fragile and subject to major injury.
- b. There is no assurance that the area can be adequately restocked within five years after harvest.
- c. Aesthetic values outweigh other considerations.
- d. The method is preferred only because it will give the greatest dollar return or the greatest unit output.

3. Clear-cutting should be used only where:

- a. It is determined to be silviculturally essential to accomplish the relevant forest management objectives.
- b. The size of clear-cut block, patches or strips are kept at the minimum necessary to accomplish silvicultural and other multiple-use forest management objectives.
- c. A multidisciplinary review has first been made of the potential environmental, biological, aesthetic, engineering and economic impacts on each sale area.
- d. Clear-cut blocks, patches or strips are, in all cases, shaped and blended as much as possible with the natural terrain. (p. 286).

These guidelines are clearly designed to incorporate non-timber values into the choice of harvest method.

An alternative to clear cutting is strip or small block cutting designed to enhance natural regeneration. This partial cutting

may lead to increased costs in a number of ways: increased area and road length required to harvest the same volume, possible damage to the remaining trees, losses to blowdown, and the costs associated with carrying the inventory (DePape and Collins, 1977). These increased costs can be considered investments in silviculture or improved environmental quality. Note, however, that there is evidence that roads within the FMA system of management are being built and maintained to higher standards in order to "access distant old timber ..., to provide summer access to winter-cut areas for silvicultural treatment and to provide recreational access for the people and visitors of Ontario". (OMNR, 1988b, 12; see also OFIA/OLMA Panel 5, 19, 28, and response to FFT Interrogatory #6 on OFIA/OLMA Panel 8 for further evidence). These higher costs reduce the extra road costs implied by partial cutting.

The Class Environmental Assessment document (OMNR, 1987b) lays out the method for choosing a harvest method in Ontario as follows:

There are three broad alternative methods used to harvest timber in Ontario: clear cut, shelterwood cut, or selection cut. The choice of a particular method in a particular area will be determined by weighing a number of factors during timber management planning, including:

- objectives of management;
- the general conditions of the forest region;
- the site conditions (soil, topography, climate);
- the existing condition (age and quality) of the timber resource;

- the species of trees and the mix of species;
- concerns of other Crown land users; and
- economics. (p.36-37).

There is no discussion of how these factors will be combined nor, specifically, what weights they will be given. Elsewhere in the same document, the statement is made that:

It is essential that the relatively low per cubic metre cost of harvesting pulpwood be maintained as this can account for 30 percent or more of the cost of a tonne of pulp, the primary product. (p.82, emphasis added).

The implication is that large area clearcutting must continue to be the harvest method of choice. The implied tradeoff is between the environmental concerns which would restrict the use of clearcutting and the competitiveness of the industries consuming the wood. The statement entails ignoring the environmental concerns unless they are consistent with low harvest costs.

There are a number of estimates of differences in costs due to modified harvesting methods in Ontario. Brace and Stewart (n.d.) observed a 20% reduction in harvesting productivity in white pine with a shelterwood silviculture system compared to partial cutting. Road costs and planning costs were significantly higher. About 20% of the residual trees were damaged.

The Timber Sales Branch of the MNR (1978) estimated that the restrictions on clearcutting and highgrading could add up to

\$15/cunit on top of an estimated average cost of \$85/cunit in 1977.

A recent study in Ontario (Johnson and Smyth, 1987) found that stripcutting did increase harvesting costs over clearcutting, but when stripcutting was also viewed as a silvicultural treatment its costs were intermediate between clearcutting plus seeding and clearcutting plus planting. (It should be noted that the stripcutting alternative still required planting on 50% of the harvested land.) An obstacle to the wider use of stripcutting on this basis in Ontario is that harvesting costs are paid by the logging company while silvicultural costs are assumed by the Crown. The companies have no incentive to raise the cost of harvesting even if the increased costs are more than offset by reduced silvicultural costs. In response to this situation, companies have argued that the difference in the costs of stripcutting and clearcutting ought to be considered a regeneration cost, and hence paid for by the Crown (Morrow, 1988; Oppen, 1988). A more economically efficient result might follow if companies were simply required to meet certain regeneration targets and were free to choose the preferred method. Since, however, silvicultural investments may not be profitable from the companies' viewpoint, any assignment of silvicultural responsibilities to the companies must be accompanied by clearly measurable objectives and strong financial disincentives for failure to reach them. In any event it is clear that the current

funding method is biased against the choice of modified cutting as a silvicultural technique.

One of the major reasons for "modifying" cutting patterns from the "normal" clearcutting is to combine management for timber with management for other resources. Payne et al. (1988) discuss three case studies of management for moose habitat in conjunction with timber harvesting. In the first case, Great Lakes Forest Products experienced increased costs of \$0.44/harvested cord for the first cut and \$1.84/harvested cord for the second cut. Increases were primarily due to road layout and (re)construction costs. In the second case, Abitibi Price observed increased costs of \$261/ha, again principally due to road construction and maintenance costs. In this case, moose density was three times as high in the area which had been managed for both forest resources. In the third case, the costs of modified harvesting could not be assessed. In none of these examples was it possible to compare the benefits in terms of moose habitat or moose populations with the additional harvest costs.

The choice of harvesting practices may affect the choice of road standard. For example, partial cutting systems will lead to the need for higher road standards and consequently higher maintenance costs (DePape and Collins, 1977), though there appear to be ways to reduce costs under these circumstances. As noted earlier in this subsection, increasing standards of road

construction and maintenance under the FMAs reduces the incremental costs of partial cutting. Long distance forwarding may offer significant cost savings in terms of road construction, in addition to increasing the feasibility of "patch" clear-felling and reducing environmental disturbances (Anonymous, 1978).

3.3.3. Ontario's procedures guarantee neither an even flow of wood nor maximized net social benefits.

The problem of how optimally to schedule harvesting of stands in both temporal and spatial dimensions is a difficult one. This problem cannot be solved by considering stands in isolation. It requires information on a variety of factors including proximity to conversion plants, costs of harvesting, values of timber, the relationship to other harvested areas, the changing demand for timber, and the effects of silviculture on future timber availability. Since harvesting of timber affects the flow of other forest services such as wildlife and wilderness recreation, optimal scheduling also requires attention to these non-timber uses.

The concept of sustained yield admits several definitions. Maximum sustained yield does not maximize net present value.

One of the most important paradigms in forest management that

underlies many harvest schedules is sustained yield. In natural resource economics a sustained yield is a flow of services that can be maintained indefinitely. This appears to be consistent with the concept of sustainable utilization advocated by the International Union for Conservation of Nature and Natural Resources (IUCN). According to the latter,

Sustainable utilization is somewhat analagous to spending the interest while keeping the capital. A society that insists that all utilization of living resources be sustainable ensures that it will benefit from those resources virtually indefinitely. (IUCN, 1980, section 4.1).

In what follows we treat sustained yield and sustainable yield as synonyms. Note that sustained (or sustainable) yield should refer to all the services yielded by the forest, including maintenance of ecosystems, genetic diversity, and recreation.

In forestry economics, the sustained yield of timber from a forest is closely related to the rotation period and the labour and capital applied in management. The "long term" sustained yield from a forest can be defined as the mean annual increment (MAI) times the productive area of the forest. As the rotation period increases, the MAI increases to a maximum and then decreases. (FFT, Witness Statement No. 5, pp.6, 22). Application of intensive silvicultural techniques may increase or advance the maximum MAI. Any particular sustained yield will be associated with a corresponding stock of standing timber with an appropriate age distribution.

Sustained yield, a steady state that can be reproduced indefinitely, should be distinguished from the transition to steady state. Harvesting the "long term" sustained yield from a forest when the stock of standing timber is too small will deplete the forest. Harvesting the long term sustained yield from an unmanaged forest will tend to convert it into a "normal" forest. It is also possible, however, to accelerate the harvest from an unmanaged forest so as to cut more in the early stages of transition and less in the later years. In this case, the harvest in the later years of the transition may fall short of the long term sustained yield.

The concept of sustained yield poses three problems.

1. Is it desirable to harvest a sustained yield?
2. If so, what level of sustained yield should be chosen?
3. What is the most appropriate transition path to sustained yield?

Departures from sustained yield management may be short-term or long-term. There is general agreement that it is desirable to permit short-term deviations from an absolute even flow of wood. However, textbook definitions stress that "in the long run and on the average ... current harvest [must] equal current growth".

(Davis, 1966, 8 cited in FFT, Witness Statement No. 5, 8). Short term deviations from even-flow management may increase the NPV of the harvest by allowing increased production during periods of

high demand, etc.

In the long term, the alternative to sustained yield management is "mining" the forest: harvesting it without considering the nature of the subsequent growth. Both harvesting methods which reduce the productivity of the forest land and those which alter the species composition of the forest should be considered non-sustainable. Under some circumstances such mining will increase the measured NPV of the timber services provided by the forest. It does, however, violate the concept of sustainable development discussed in section 2.2.3 above. It may easily be that the general public is willing to sacrifice a certain amount of measured timber benefits to achieve the values associated with sustainable utilization. That is, the general public may be willing to pay more than enough to compensate workers and companies involved in resource extraction for the losses a lower harvest imposes on them. In practice, this compensation might appear as adjustment assistance to those displaced from their current logging employment. It should be noted, however, that the concept of "mining" the forest necessarily envisages an eventual large decline in industry employment.

The choice of rotation period, and hence the level of sustained yield, has been the topic of much debate in forestry economics. Foresters often speak of the "biologically optimum rotation" as one which maximizes the mean annual (physical) increment. When

the value of wood depends on the diameter of the tree, however, the mean annual increase in **value** may occur with a longer rotation. Once the costs of planting and silviculture are recognized, the rotation which maximizes mean annual **net** receipts (wood revenues less planting costs) is even longer (Samuelson, 1976, 477). On the other hand, the NPV criterion will generally select a shorter rotation period, because any positive discount rate (i.e. interest rate) reduces the value of distant payments. Economists generally agree that the correct solution to the general problem was seen by Faustmann (1849), who argued that the rotation period should be chosen to maximize the NPV of the forest calculated for all rotations in perpetuity.

Perhaps the most critical point is that the correct rotation period depends on the use of the wood. The Timber Management Planning Manual recognizes that the optimal rotation for pulpwood is shorter than that for sawtimber. It is also true that the optimal rotation period for wildlife production may be very short and that the optimal rotation period for wilderness recreation and amenity values may be much longer (Calish, Fight and Teegarden, 1978; FFT Witness Statement No 5, ch. 4). Maximization of the NPV of the forest proper must take all these factors into account.

The choice of an adjustment path to sustained yield presents serious problems. On the basis of easily observed costs, an

adjustment path which begins with a high harvest and then dips below sustainable levels may have a higher present value than an even-flow adjustment path. On the other hand, such a path implies a steadily declining flow of wood for many years. This may pose adjustment problems for small communities heavily dependent on timber.

Ontario's "Sustained yield management" will not result in even flows of timber.

The provisions for Forest Management Agreements under the Crown Timber define sustained yield as "...the growth of timber that a forest can produce and that can be cut to achieve a continuous approximate balance between growth of timber and timber cut" (R.S.O. 1980, c. 109, s. 6). This may be interpreted as being consistent with the popular notion that sustained yield means a constant harvest, leading to an even flow of timber, and no long-term change in the forest.

Other documents, however, imply a much weaker constraint on forest management than the Crown Timber Act does. For example, the Class Environmental Assessment document states that "...the practical meaning of sustained yield is continuity of harvest." (p.97) and that the "[t]he actual yield may fluctuate from year to year; however, an amount should flow year after year for the length of that time period." (p.98). The time period is not

specified, nor is a minimum amount suggested. The Class EA thus appears inconsistent with the Crown Timber Act, at least is so far as Forest Management Agreements are concerned.

An area-based harvest calculation is closely linked to the policy of "sustained yield", for as Baskerville (1986) noted: "It is implied that harvesting a constant area every year will make a consistent flow of volume available to industry." (p.28). Yet there is no indication that the sustained yield policy is effective in this regard. Based on an examination of five management units, Baskerville (1986) argues:

...if the management plan is precisely implemented, and the future unfolds precisely as laid out in the plan, there is substantial doubt as to the extent the first objective of the Management Plan, that is meeting industrial wood volume needs, will be met (p.37).

Indeed, it is likely that the current MADs will exceed future long-term supplies (FFT, Witness Statement No. 5). A study prepared by Lakehead University (1981) identified seven reasons:

- (i) accelerated harvests with the average age method will give lower harvests in the future;
- (ii) withdrawals of areas from wood production;
- (iii) full utilization is not achieved;
- (iv) the Forest Resource Inventory (FRI) overestimates the amount of available wood;

- (v) management plans were outdated and incomplete;
- (vi) regeneration is inadequate; and
- (vii) regional shortages have already developed.

As an example of the last point, a review of the management of jack pine in the Englehart Unit in northern Ontario concluded that:

...during the first 16 years of management, jack pine has been overcut both in terms of volume and of area harvested ... Overestimates in the original inventory, loss of standing volumes and the magnitude of the cutover area itself all point to possible over-harvesting. (Armson, 1977, p.2-17).

3.3...4 Ontario's timber production targets do not favour maximization of the net present value of the forest because they are unrelated to the costs of production and silviculture.

Beginning in 1972, the Ontario MNR undertook an extended land use planning exercise that lasted for over a decade. The results were the regional Strategic Land Use Plans (SLUP) and the District Land Use Guidelines (DLUG). District Land Use Guidelines include targets for various outputs of forest land, including timber volumes, fishery and hunting targets, and recreational opportunities. The Ministry incorporated input from other Ministries and interested parties in developing the Guidelines. The timber production targets were based on the Forest Production

Policy. This policy will be reviewed in Section 6.

Baskerville (1986) is critical of the "top down" approach for developing timber production targets:

The existing targets that were distributed downwards are clearly inconsistent with the Management Unit capabilities and/or markets in at least the instances examined. This should not be surprising since those targets were assigned, rather than determined as biologically [or economically] necessary, and feasible, on the basis of actual forest structure on the Units. (p.64-65).

In summary, harvest scheduling in Ontario is based on a set of unrealistic and inappropriate assumptions. It is unlikely that it will be possible to adhere to currently projected harvest schedules. The harvest schedule will not conform to the popular idea of sustained yield.

3.4. Ontario's procedures governing regeneration are based on faulty economic reasoning and lead to excessive expenditures on artificial regeneration.

Regeneration involves a wide range of interventions in forest ecosystems, with the general aim of establishing a crop of commercially desirable trees on disturbed sites (areas that have been harvested, burnt, or damaged by insects). Depending on the ecological conditions at the site, no action may be required; the area may regenerate naturally to a suitable density of valuable trees. As Baskerville (1986) notes:

Silviculture is used to make more wood available over a

shorter period of time than would otherwise occur without its application, and the use of silviculture therefore implies some future limitation to wood supply which is worth correcting at the cost of silviculture (p.45).

It is possible to have too much silviculture. Many calculations indicate a negative net present value for silvicultural investments (e.g. Anderson, 1979). This is true even when wildly inappropriate values for the value of wood are used (e.g. Hynard, 1984, 15). A negative NPV for a silvicultural investment indicates that additional harvest obtained through silviculture is not worth as much as the labour and capital used up. The investing agency would be better off using its scarce resources elsewhere.

In Ontario, reforestation is the financial responsibility of the MNR. In FMAs, these activities are carried out by the company in accordance with the timber management plan, according to ground rules negotiated between the company and the MNR. The company benefits from the increased future wood supply resulting from intensive silviculture, but it does not pay the full cost of silviculture. This provides an incentive for the company to undertake more intensive silvicultural investments than is socially desirable.

Silviculture spending has increased markedly over the last few years. The area site prepared went from 68 thousand ha in 1983 to 107 thousand ha in 1987 (OMNR, 1987d). Mechanical site

preparation has roughly doubled in Ontario in the last decade and accounted for about 84% of all site preparation in 1985-86 (Smith, 1987). Production of seedlings has increased dramatically in the last few years in Ontario from 84 million in 1982 to 155 million in 1987. The increase is due almost entirely to the development of private containerized seedling greenhouses. They provided close to half of the 1987 production (OMNR, 1987d). There appear to have been economic inefficiencies in the establishment of these private greenhouses (Office of the Provincial Auditor, 1986).

The increase in production of containerized seedlings is coupled to a major shift to planting container stock (up from 7 thousand ha in 1983 to 40 thousand ha in 1987) (OMNR, 1987d). In 1986-87, 43.9 million trees were produced under the COFRDA program at a cost of \$10.0 million (Anonymous, 1987). Seedling stock is provided free of charge to FMA holders (OMNR, 1988).

3.4.1. The MNR's economic rationale for artificial regeneration is based on inappropriately high estimates of the value of timber.

A stand should be artificially regenerated if the net benefits are greater than the alternatives, including allowing natural processes to revegetate the site.

The net benefits of artificial regeneration will not always be positive. As Armson (1976) noted: "It is a common myth that every acre logged should be regenerated." (p.70). The sites that should be artificially revegetated (if any) are those which produce net positive values, i.e. those with the highest productivity, closest to the wood-processing plant, with the easiest access, and lowest logging costs. The benefits and costs considered should include external costs and benefits.

Reforestation regulations in Alberta appear to be an attempt to capture some of these externalities. In that province, reforestation costs are viewed as a cost of doing business (Environmental Council of Alberta, 1979). This has two implications: forests should not be cut where they cannot be regenerated and the cost of reforestation should be minimized.

Procedures in Ontario imply an appropriate attempt to allocate regeneration expenditures in the most productive way, but economic analysis of silvicultural decisions is based on an overestimate of the value of wood and an inappropriately narrow definition of cost.

The Timber Management Planning Manual (OMNR, 1986e) gives the following description of how the requirements for regeneration and maintenance will be determined:

[It] will involve such things as:

- choosing between intensive and extensive management;
- establishing priorities in the choice of sites;
- establishing priorities for maintenance and renewal;
and
- determining the relative return on expenditure for
different alternatives (p.10).

The last potential action suggests that an economic criterion might be used. Baskerville (1986) found that the amount of silviculture carried out in Ontario was based on administrative determinations, and, in particular, depended on the budget available. He saw "...no evidence of a process that ensured that the budget was spent on the sites and stands that would give the best marginal return in long-term flow of raw material from the Unit." (p.46).

Ontario has begun moving to a so-called "prime sites" approach which establishes the ranking for silvicultural treatments. This strategy will direct artificial regeneration programs to the sites which will produce the highest returns for the dollars invested while ensuring natural regeneration on the remainder (OMNR, 1986b, p.3). The description of the approach suggests that selection of sites might be based on the gross value of the wood-based end products, rather than on the net value for all goods and services.

Hynard (1984) has recently attempted to develop an economic analysis of silviculture decisions in Ontario based on a net present value determination. He argues that:

...stumpage values alone can justify few silvicultural ventures in Ontario (which explains why private landowners here do not invest in timber production in a meaningful way). The Ontario government makes investments in silviculture because the economic value to society of wood is far greater than the Crown dues alone (p.6).

Instead, he uses an estimate of the value added per unit of wood as a measure of the economic value to society. That is, he assumes that the value of a cubic metre of wood used in newsprint production is equal to value added in newsprint production divided by the number of cubic metres of wood used for newsprint production. This approach is clearly fallacious. First, the increase in value added from an incremental ton of woodfibre is not necessarily equal to the average value added per ton of woodfibre because the woodfibre in question may simply displace fibre from other sources or the labour and capital required to process it may not be in place. Second, the increase in value added from an incremental ton of woodfibre cannot all be attributed to the woodfibre. Some portion of the value added must be attributed to the labour and capital used to process it. Finally, the increase in value added in newsprint is not a net contribution to GDP if the labour and capital used in newsprint production have alternative uses, as they obviously do.

Hynard's overvaluation of wood was even more dramatic in his testimony to the Environmental Assessment Board.

...what is the value of that cord of wood [?]. We know it is a large value but we don't -- I don't know exactly what that value is. Of course it varies from cord to cord and that's important, too.

For example, when you buy your hardwood furniture I will bet you are paying \$15,000 a cord for your wood and that \$15,000 went into the economy. If you buy pallets -- hardwood pallets, that's about \$500 a cord for your wood. And this simple fact explains two things: First of all, why hardwood foresters try to grow quality trees; because there is better economic value and that's part of our purpose of management....(Transcript, p 13078)

and again

Private landowners do not invest in forestry to a large degree because the rate of return is simply too low. And the Government of Ontario, on the other hand, invests in forestry because the benefits to Ontario society from a cord of wood are enormous. Those benefits include people working in the mills, they are paying their taxes, they are not collecting unemployment insurance, they are buying their skidders that are made in Woodstock, they are buying their Chevrolets that are made in Oshawa. Those are all values that Ontario society -- people of Ontario receive as a result of the Government of Ontario making this investment.

Now, as I said I am not an economist and .. I don't have the answer as to what that cord of wood is worth to society."
(Transcript p.13076)

Because Hynard is not an economist, he may be excused for not knowing that economists have made a careful study of how to define the value of a resource such as wood. The results are well established, uncontroversial, and generally available (Canada, Treasury Board, 1976). They have been summarized in Section 2 of this document. Hynard's comments are totally inconsistent with the accepted body of economic literature on valuing resources. But because statements like his are so often

made, it is worthwhile to examine them carefully and to point out the difficulties with them.

First, to say that when one buys furniture one is paying \$15,000 a cord for wood is to ignore that the \$15,000 is also being used to recompense the retailer of the furniture, the truckers used to transport the furniture, the workers who manufactured the furniture, the workers who operated the sawmill to produce the lumber for the furniture, the workers who produced the other components of the furniture, etc. To say that the \$15,000 payment is entirely for wood is to assert that all these other workers could have been paid nothing and the furniture would still have been produced. This is nonsense. Similar comments apply to valuing the wood in hardwood pallets at \$500 a cord.

Secondly, discussions of this kind cannot be fruitful without a definition of "benefits to Ontario society" from a cord of wood. As a first approximation, economists define the "benefits to Ontario society" from a cord of wood to be the increase in aggregate consumption (or, equivalently, aggregate income) available to the residents of Ontario created by the presence of the wood. Alternatively the benefit may be considered the amount by which the total income of Ontario residents would be reduced if this cord of wood were not available. Total income must be interpreted as including the value of non-marketed services, as described in Section 2 above.

The benefits of wood to Ontario do not include "people working in the mills", they only include the extra income people can earn from working in wood-processing mills rather than some other job. If the supply of wood is reduced by a small amount stretched over many years, the consequence will be a gradual reduction in the number of jobs in wood-processing mills. Much of the adjustment will come from young people who will decide to pursue careers in some other employment. These people will not suffer much loss in income from a reduction in wood-processing opportunities.

The benefits from wood do not include the entirety of taxes collected from people working in wood-processing industries, only the extra taxes that they would pay by working in wood-processing rather than somewhere else. This will form part of the extra income described immediately above. It will not be a great amount if reductions in wood supply are slow and spread over many years. Moreover to count both the extra gross income earned in wood processing mills and the taxes paid from that income is to count the same benefit twice.

The unemployment insurance not collected by workers employed in mills should not be counted as a benefit either. Unemployment insurance payments simply transfer claims on consumption goods from the people who pay premiums to the people who collect unemployment insurance payments. By not collecting UI payments

the mill-workers reduce their consumption and other workers or the general taxpayers increase theirs. Nothing happens to the total value of goods and services produced in Ontario, or equivalently, to the total incomes earned by Ontario residents.

Purchases of skidders in Woodstock give rise to benefits to the residents of Ontario only to the extent their incomes are higher because of the purchase (or to the extent the value of aggregate production rises because of the purchase). Unless all the inputs into skidder production are unemployed, an increase in skidder production will decrease the production of other goods and services. Thus the net increase in the value of goods and services produced is less than the value of the skidders produced. Under normal circumstances, the value of the displaced production of other goods and services roughly equals the value of the skidder production, so the forest industry expenditures on skidders produced in Woodstock should not be counted a benefit to the people of Ontario (see Canada, Treasury Board, 1976, 22-24).

Purchases by forestry workers of Chevrolets made in Oshawa are analagous to purchasers of skidders made in Woodstock. They should not be counted as benefits arising from the supply of wood to the forest industry.

Hynard's testimony also indicates that the financial analyses conducted in Ontario are conducted on an excessively narrow

definition of cost. He states, for example:

And so I look at the costs that I am incurring as a unit forester, it is what it is going to cost me to carry out that treatment. I don't pay for the nursery stock but my employer does, so that's in there too. ... (Transcript, p.13075)

Clearly any costs incurred by parties other than the government of Ontario are excluded. Loss of wilderness recreation benefits would be an example. This is inconsistent with Hynard's treatment of benefits of timber production in which all the alleged benefits to all the people of Ontario are included. The social cost-benefit techniques recommended in Section 5 of this statement are designed to take into account all the benefits and all the costs of timber management decisions, regardless of who receives or pays them.

Elsewhere (p.15) in his analysis, Hynard assumes that, if some silvicultural investments have negative present values, alternative investments are justifiable as long as their payoff is no worse. This is inconsistent with accepted principles of project appraisal. If the NPV of artificial regeneration is negative, the appropriate decision is not to artificially regenerate the stand. The approach taken by Hynard can only be justified if a fixed amount of money must be spent on silviculture and the issue is only to rank alternative sites. This kind of assumption seems to flow from the constraints of Ontario's present Forest Production Policy which specifies targets for wood supply without any examination of their economic

feasibility.

Hynard's approach to financial analysis is being taught to government and industry foresters. (Transcript, p 13068). Apparently it has been adopted in some areas. Teskey (1986) describes an economic "prime sites" model for the Northeast Region that is very similar to Hynard's approach. A low discount rate (3%) is used. Prices are based on average value-added because it is Prices are based on average value-added because it is "...a truer reflection of the worth of the wood to the province than is stumpage." (p.115). Perhaps the intent of this modelling exercise is most clearly revealed by Teskey's comment that "...this [model] will greatly enhance the credibility of forest investment decisions." (p.117).

In an economically sound analysis, Anderson (1979) acknowledged the problem of trying to estimate the net value of timber in the absence of market information and concluded that despite their imperfections, stumpage values were the best available approximation to economic rent. On the basis of his calculations using provincial averages, silvicultural investments cannot be justified on economic grounds. In addition, including recreational benefits did not improve the picture significantly; the net value of recreational benefits would have to be unreasonably high to justify artificial regeneration. Given current wood costs and values, regeneration programs should be

selectively applied to only the small number of sites for which net present values are positive.

Given Anderson's analysis, why is so much silviculture carried out? The answer seems to be that the Ministry has no incentive to behave in an economically efficient manner, beyond keeping within an administratively constrained budget. At the same time, the Office of the Provincial Auditor (1986) noted substantial areas that were not assessed for regeneration success, apparently because of lack of funds.

3.4.2. The choice of regeneration method is not based on NPV considerations and is biased against natural regeneration based on modified harvesting techniques.

The different possible methods of regeneration may produce substantially different outcomes in terms of timber produced and external costs and benefits. For example, relying on modified cutting techniques to enhance natural regeneration may entail greater harvesting costs than the use of artificial regeneration because of species, density, and age variation. On the other hand, it may lead to ecologically more stable communities and more wildlife and reduced herbicide use.

Ontario has prepared a series of silvicultural guides for each of

the major working groups in the province. There is very little mention of economic criteria in any of the guides; they are designed to provide biological information.

According to the Class Environmental Assessment document,

[t]he decision of whether to rely on natural or artificial regeneration is based on many factors, such as management objectives, nature and location of the area to be treated, availability of seed sources (either for natural or artificial regeneration), and the availability of planting stock. The costs may vary considerably, and generally are least for natural regeneration and greatest for artificial regeneration. (OMNR, 1987b, p.45).

This quotation does not refer to the net value of the tree that will ultimately be harvested. This suggests that silviculture is linked to harvesting only as far as incorporating the effects of harvesting practices on silvicultural activity, but not to matching silvicultural decisions to future wood quality and quantity.

Integration of harvesting and regeneration

One of the key issues in determining the optimum levels of harvesting and regeneration involves the identification of the agent(s) who actually carries out forest management. For each of the activities, an optimal decision requires that the agent have the appropriate information and incentives and that the external costs and benefits of his or her decision be properly incorporated. For example, Armson (1976) identified a set of

conditions under which more effective forest management was likely to result:

...when those concerned with the planning and implementation of harvesting operations also have the responsibility for full forest management (p.22).

...when those concerned primarily with the harvesting and utilization of forest crops have control over the location and choice of management, especially silvicultural practices which alter crop yields (p.23).

...when a large licensed area is treated as a single forest estate for management (p.24).

Armson's recommendations are directed towards trying to reduce the external costs and benefits among timber harvesting related activities. For example, if loggers do not bear the costs of replanting, harvest rates will tend to be higher than the economic optimum and areas that would not regenerate adequately might be harvested.

In Ontario, the holders of FMA areas are required to combine the activities of harvesting and silviculture. As is clear from the first three FMA five-year reviews (OMNR, 1985b; OMNR, 1987c; OMNR, 1988), the absolute and relative levels of various activities have deviated widely from the levels in the management plans. These deviations suggest that the appropriate signals and incentives are not in place to coordinate activities properly.

As we have stressed repeatedly in this report, subsidization of specific silvicultural expenses by the province will lead to excessive investment in artificial regeneration, even when

harvesting and silviculture decisions are under common control.

3.5. Ontario's procedures governing the tending of regenerated forests are not based on the maximization of NPV and do not account in any way for the environmental costs of herbicides.

Post-regeneration treatments consist of a variety of techniques designed to increase the volume or value of the timber in a stand, or to reduce the rotation period by increasing the growth rate. Most post-regeneration treatments, including fertilization, precommercial thinning, commercial thinning, and pruning, have not been widely used in Canada. The one exception to this pattern is the use of herbicides to kill vegetation competing with valued softwoods.

The use of herbicides in forestry has been the source of considerable controversy (see Dunster, 1987b). They are claimed to reduce the competition for the more highly valued conifers (e.g. Dennis, 1984). The documented effects are more ambiguous. For example, Lehela (1981) observed a significant height increase of balsam fir following treatment with 2,4-D, but no effect for spruce. The use of phenoxy herbicides (including 2,4-D) has been linked to increased risk of certain human cancers (e.g. Hoar et al., 1986). They may also reduce wildlife browse availability (e.g. Payne et al., 1988).

Just less than 75% of stand tending on all Crown land in Ontario is herbicide spraying; on FMA areas the figure is over 97%. For all Crown land, hand cleaning and "thinning and improvement" make up most of the remainder of the 80 thousand ha (OMNR, 1987d). The area tended has more than doubled since 1983, with most of the increase from a doubling of area sprayed with herbicide (OMNR, 1987d). This increase is closely correlated with the increase in provincial and federal subsidies provided through the Canada Ontario Forest and Regional Development Agreement (COFRDA). (Kuhnke, 1989:59,78)

3.5.1. Procedures for determining whether treatment will be applied to NSR lands is not based on considerations of return to investment and appears to commit the fallacy of considering sunk costs.

The fallacy of sunk costs is the error committed when past expenditures are allowed to influence current decisions. Past expenditures are relevant only to the extent they have affected current conditions. Areas that are NSR should only be treated if treatment increases the net present value of the site, given its current condition. Money previously spent on the site is sunk and should not influence the choice of treatment area. Future, or expected, benefits and costs should determine the choice of treatment area.

The OMNR has distinguished six classes of NSR land, based on a judgement of treatment (if any) required and cost of that treatment. For example, NSR Class 2 requires tending treatment, Class 3 requires regeneration treatments that can be carried out at current costs, Class 4 regeneration costs will be 50-100% above current costs, and Class 5 requires regeneration treatments costing 100% or more above current costs (OMNR, 1986e). The classification is used for deciding which NSR must be treated by FMA holders. Classes 4 and 5 are not required to be treated.

The classification is striking for two reasons. First, land is classified only on the basis of cost; no accounting of benefits of treatment appears to be made. Second, current costs are used as a baseline, yet there does not appear to be an analysis of whether current costs are an appropriate level of investment or not. The classification might be a reasonable crude estimate of cost-effectiveness if the outcome of the treatments were the same. This is unlikely.

The Regeneration Survey Manual for Ontario (OMNR, 1981) states (p.2):

Areas that have received treatment will be given priority over untreated areas and a greater emphasis will be given to conifer working groups as compared to hardwoods.

Neither priority is properly placed. Previous treatments should be considered as sunk costs, thus areas should not be ranked for

treatment on the basis of previous spending, but only on the basis of expected, future net benefits. (Earlier treatment attempts may, of course, influence the estimate of the probability of treatment success at a given site.) Conifer working groups should only be chosen over hardwood groups if they will produce a greater net value.

This error of improperly considering sunk costs is also evident in the document describing the COFRDA (Anonymous, 1985a):

It is imperative that tending be conducted to secure and then to enhance the extremely large investments made within the forest renewal program."(p.25).

The investments may have been made in anticipation of future tending, but only the benefits of further tending given current conditions should influence the current allocation of resources.

3.5.2. The choice of treatment method appears to ignore potential environmental costs and is biased in favour of herbicide use.

After a detailed evaluation of the economics of herbicide use in forestry, Roberts et al. (1985) concluded that benefit-cost analysis was not particularly useful in making decisions in this area. They identified the lack of response (efficacy) data as the most serious obstacle to a proper analysis. They also emphasized the large uncertainties in the economic data and the need for a site-specific approach. A simulation model was employed to examine the sensitivity to a set of economic assumptions. They

compared herbicide use and manual weeding. Based on a net present value criterion, the herbicide use was preferred. At a discount rate of 4%, manual weeding benefits were negative (-\$482/ha to -\$151/ha) while herbicide use benefits ranged from -\$23/ha to \$304/ha.

It should be noted that this analysis is limited in scope. It is only a simulated financial analysis and it does not include any consideration of effects on non-timber values (including human health).

Cost-effectiveness of manual methods may increase significantly in the future. As Roberts et al. (1985) note:

Stavins et al. (1981) indicated that manual release costs may fall over time, not only because of increased experience of contractors, improved contract specifications, more careful site selection and avoidance of heavily weeded areas, but also because aerial application costs are apparently rising, particularly for public agencies, which are incurring increasing costs for administration, environmental monitoring, and legal and public relations activities associated with the use of herbicides. (p.218).

The costs of non-chemical tending in Ontario have not been well-documented. Lemon (1981) cites a figure of \$200 per ha in the Nipigon District. He notes that the productivity of work conducted under government make-work programs may be extremely low, thus the comparison with professionally conducted chemical programs may not be a fair one.

In Ontario, the MNR appears to be firmly committed to the use of

herbicides. For example, under the FMA Ground Rules, companies are not required to tend if herbicide is not available (OMNR, 1986e). The COFRDA program has supplied substantial funds for stand tending (Anonymous, 1985a). Again, the choice of method appears to be set:

The principal method of tending must of necessity comprise aerial or ground application of approved chemical herbicides, although mechanical or manual tending may prove cost-effective in some cases. (p.25, emphasis added).

Despite this commitment, past tending programs appear to have been below target levels (Office of the Provincial Auditor, 1986).

3.6. The procedures governing decisions to protect forests from fires and insects do not evaluate a sufficiently wide set of alternatives.

Protection is intended to reduce the costs of fire and insect attack. The negative impacts of fire include suppression costs, social disruption, interruption of transportation, disruption of scheduling by the woods industries and silvicultural programs, reduction in tourism, and private property losses. The positive impacts include stand regeneration, and creation of age class diversity for both recreation and wildlife. Similar negative and

positive impacts are associated with insect attack.

In Ontario, fire losses in area and value terms vary tremendously from year to year. For example, in 1986 145,561 ha burned compared to 1,007 ha in 1985 and 560,305 ha in 1980 (OMNR, 1987d). The OMNR estimated the economic damage associated with these areas burned as \$20 million, \$70 thousand, and \$72 million, respectively (OMNR, 1987d). It is not clear what the basis for these latter estimates is.

Gross (1985) estimated that insects led to an annual average loss of 15.5 million m^3 between 1977 and 1981. For comparison, the harvest from Crown lands in 1981 was 18.7 million m^3 (Smyth and Campbell, 1987). Gross did not place an economic value on the loss to insects.

3.6.1. Although it is recognized that protection should be provided to high valued forests first, there is no indication that protection has been demonstrated to increase the NPV of the forest.

Economically efficient protection maximizes the net present value of the resource less the cost of the protection program. These net values should take all uses of the forest into account.

The MNR is primarily responsible for decisions about protection

and the subsequent actions. Under the FMA Ground Rules, companies recommend areas to be treated by insecticides "...to provide the required level of protection." (OMNR, 1986e, p.202).

For fire protection, the OMNR has developed a productivity curve "...that can predict the expected area burned on the basis of amount spent on [fire] protection." (p. 53, Goodman, 1985). It is not clear whether any attempt has been made to assign economic values to the area burned or whether this curve has been used in practice. Another program by the MNR ranked timber values in the Red Lake District to set fire prevention and suppression priorities (Woods et al., 1985).

With respect to protection against insects, Carrow (1983) summarized Ontario's policy for protection of forests against the spruce budworm. It consists of three objectives:

1. suppression of epicentres;
2. containment of outbreaks or developing outbreaks; and
3. protection of high value or commercially operable forest areas.

High value forests include three categories: forests in which large investments have been made (e.g. seed orchards or tree nurseries), forests with aesthetic values (e.g. parks), and forests with high "ecological value", e.g as sources of genetic material. Commercially operable forests will be protected (i.e.

sprayed) if they are scheduled for harvest within the next 10 years, if the balsam and spruce are essential to the mill's wood supply, if balsam and spruce constitute more than 40% of the merchantable volume or value, and if there is no alternative short-term supply. This analysis properly considers future values rather than sunk costs.

Baskerville (1986) observed that there was no apparent integration between protection actions and timber management planning: "A management plan cannot be implemented as written without protection from random natural harvests, and protection, where it appears in the plan, is not related to maintenance of wood flow." (p.49).

3.6.2. Although the EA document calls for a comparison of the economic costs and benefits of protection, separation of the timber management and protection decisions bias the choice of protective method.

The risk of infection and fire can be affected by harvesting and silvicultural decisions. For example, large area clearcutting may enhance competition from unwanted species and increase susceptibility to budworm infection. (FFT, Witness Statement #3,14). For both fire and insects, the choice of method is dependent on the values to be protected and the cost of protection. The relevant question is what level and method of

protection leads to the greatest increment in net values? The Class Environmental Assessment document (OMNR, 1987b) discusses the planning procedures for protection operations and the evaluation of options for selecting among possible actions:

The analysis of the options, which provides the basis, and supporting rationale, for the selection of a recommended course of action, involves an evaluation and comparison of:

- (i) their relative effectiveness in protecting the forest and controlling the insect/disease infestation;
- (ii) estimated economic costs and benefits;
- (iii) concerns of other MNR program groups and other Crown land resource users; and
- (iv) potential environmental impacts, and measures to prevent, minimize or mitigate the impacts. (Appendix III, p. 4).

This is the only place in the Class Environmental Assessment where an explicit comparison of costs and benefits is suggested. Yet given the level of understanding in Ontario of the economic dimensions of the forest, it is clearly not possible to evaluate the costs and benefits properly for all uses of the forest, let alone for the timber resource.

In the calculation of the MAD, no reduction appears to be made for insects or fire. (FFT, Witness Statement No. 5, 15). The

implicit assumption is that fire and insect attack are completely unpredictable and that only short-term reactive programs are possible. This introduces a bias against more environmentally benign procedures. Public funding of spraying and fire protection again biases the selection of protection technique against silvicultural or harvesting decisions that would increase harvesting or planting costs for private firms.

4. ASSESSMENT OF THE CLASS EA DOCUMENT

This section reviews the procedures proposed in the Class EA and concludes that they will not lead to "wise management" of the forest estate. That is, the proposed procedures are not likely to select timber management options which maximize the net social benefit derived from the forest estate.

4.1. A section-by-section comparison of the EA document to the requirements of the EA Act reveals many specific weaknesses in meeting the requirements of the legislation.

This section of our statement will examine the adequacy of the Class EA document for its stated purpose, in part by applying some of the criteria described above. (In this section, references to the Class EA document are given by page number only).

Section 5 of the Environmental Assessment Act requires that an environmental assessment consist of:

- (a) a description of the purpose of the undertaking;
- (b) a description of and a statement of the rationale for,
 - (i) the undertaking;
 - (ii) the alternative methods of carrying out the undertaking; and
 - (iii) the alternatives to the undertaking;
- (c) a description of,
 - (i) the environment that will be affected or that might reasonably be expected to be affected, directly or indirectly,
 - (ii) the effects that will be caused or that might reasonably be expected to be caused to the environment, and
 - (iii) the actions necessary or that may reasonably be expected to be necessary to prevent, change, mitigate or remedy the effects upon or the effects that might reasonably be expected upon the environment, by the undertaking, the alternative methods of carrying out the undertaking and the alternatives to the undertaking; and
- (d) an evaluation of the advantages and disadvantages to the

environment of the undertaking, the alternative methods of carrying out the undertaking and the alternatives to the undertaking. (R.S.O. 1980, c. 140, s.5).

Furthermore, section 41 of the Act makes provision for consideration of a class of undertakings.

A class of undertakings under this Act or the regulations may be defined with respect to any attribute, quality or characteristic or combination thereof and may be defined to include any number of undertakings under one ownership or more than one ownership and whether or not of the same type or with the same attributes, qualities or characteristics. (R.S.O. 1980, c. 140, s. 41).

The Ministry of the Environment has developed procedures for environmental assessment of all undertakings within a class. Documents published by the MOE make it clear that a Class Environmental Assessment approves a set of procedures to be followed in projects falling into the A class. (OMOE, A Proponent's Guide 1987, p.14). The procedures approved in a Class EA are expected to provide the same type of protection for the environment as would be provided in individual assessments.

This section of our statement considers whether each of the section of the Class Environmental Assessment for Timber Management meets the criteria established in the Act.

4.1.1. The DESCRIPTION OF THE PURPOSE OF THE UNDERTAKING is not operational (i.e. its achievement cannot be measured) and is not linked to its net social benefit.

The Class Environmental Assessment document states that:

The purpose of the undertaking is to provide a continuous and predictable supply of wood for Ontario's forest products industry. (p. 8).

This statement of purpose is very imprecise. It leaves open the following questions:

1. What does continuous mean? Does it mean continuously declining? Constant? Continuously changing up and down in a cyclic (and therefore predictable) fashion?
2. What does predictable mean? Does it simply mean that the forest products industry knows in advance how much wood will be made available? How far in advance is the prediction made? What deviation from the prediction is acceptable?
3. What is the industry referred to? (Baskerville (1986) also criticizes the MNR for not defining the industry concerned.) What about the industries which produce goods and services from the forest, but which do not

require wood (e.g. hunting, fishing)?

4. Is this wood to be made available independent of the cost of providing it? Independent of the environmental impacts of timber management? Independent of the environmental impacts of the forest products industries?
5. At what price will the wood be made available?
6. What kind of wood will be provided?

In the absence of answers to these questions, the undertaking is so poorly defined that an extremely wide range of possible actions could be construed as being part of the undertaking. For example, supplying a sawmill with one tenth of its normal requirements, clearcutting Algonquin Park, and providing hybrid poplar from eastern Ontario to the pulp and paper mills in Thunder Bay would all be consistent with the statement of purpose.

The statement of purpose potentially conflicts with the stated objective of the forest management program on Crown land in Ontario, as, for example, from the Timber Management Planning Manual for Crown Lands in Ontario:

The objective of forest management on Crown land in Ontario is to provide for an optimum continuous contribution to the economy by forest-based industries consistent with sound environmental practices and to provide for other uses of the forest. (OMNR, 1986e, p.5)

This objective is much more restrictive than the statement of purpose in the Class Environmental Assessment and would preclude some of the possible actions mentioned above. It certainly differs in emphasis, e.g. continuous supply of wood vs. continuous contribution to the economy. There is also the theoretical possibility that an optimum contribution to the economy would be zero.

Even this latter objective is not adequate. Baskerville (1986) describes it as nice-sounding boilerplate. The phrase "an optimum contribution to the economy" is open to many interpretations. It is consistent with the goal of economic efficiency discussed in Section II of this statement. In that case, the "optimum contribution" of the forest industry would be that which maximizes the properly measured net benefits derived from the forest. Unfortunately, "optimum contribution" might also be interpreted as maximization of employment or value added by the industry. Such an interpretation ignores the non-timber uses of the forest and often neglects to adjust gross increases in employment and value added for reductions experienced elsewhere

in the economy.

4.1.2. The DESCRIPTIONS OF THE UNDERTAKING, ALTERNATIVES TO THE UNDERTAKING AND ALTERNATIVE METHODS FOR CARRYING OUT THE UNDERTAKING confuse the provincial and forest management unit (FMU) levels of analysis.

The undertaking is described as a sequence of four activities: provision of access, harvest of timber, renewal of the timber resource, and maintenance of the timber resource. The potential location of the activities is also described in terms of the portion of the province where they may occur, and the fact that they are restricted to certain parts of forest management units.

Three alternatives to the undertaking are listed. The first, the "Do Nothing/Null" alternative, provides wood to the forest products industry from either patented lands or imports, or a combination of the two. The second alternative, "Harvest With No Renewal", includes the first two activities in timber management, but does not include either renewal or maintenance activities. This is not really an alternative, but a subset of activities. The third alternative to the undertaking, "Recycling", is capable of providing some raw material to the pulp and paper industries, but not to the lumber and plywood industries.

The alternative methods of carrying out the undertaking are

described as the alternative methods of providing access, harvesting timber, renewing the resource, and maintaining the resource.

It is unclear from the descriptions in the Class Environmental Assessment precisely what the scale of the undertaking is. The description of alternative methods of carrying out the undertaking suggests that the undertaking is to be considered on stand level basis. The description of the undertaking is ambiguous about the level at which it occurs. The description of the alternatives to the undertaking clearly imply a provincial scale of consideration.

One statement which seems to shed some light on this issue is that:

the class environmental assessment approach has the added advantage of allowing matters such as the purpose of the undertaking, the rationale for the undertaking, and alternatives to the undertaking, which are the same for all management units, to be dealt with on a generic basis" (p.16-17).

This statement implies that the undertaking is to be considered at a forest management unit level and that the alternatives to the undertaking are identical for each management unit. This is consistent with the use of the Timber Management Planning Manual as a planning guide.

If the undertaking is considered at a forest management unit

level, then there are at least two problems.

- 4.1.2.1. The document fails to make clear that the best alternative use of the forest may differ from FMU to FMU.

The description of the alternatives to the undertaking is inappropriate because they should be specified at a management unit level. They have been mis-specified because, as given, they are alternative means of providing wood to the industry at the provincial level. They should instead be plausible answers to the question: What are alternative uses of the forested Crown land, labour, and capital, other than providing wood to the forest products industry, for individual forest management units?

- 4.1.2.2. The document fails to examine a sufficiently wide set of alternative methods for supplying wood to the forest products industry in any particular FMU.

The second major problem is that the alternative methods of carrying out the undertaking have been specified at too local a level. The implication is that the same alternative method will be applied over the entire management unit. Assuming for the moment that the statement of purpose is acceptable, they should be answers to the question above: What alternative means are there of providing a continuous and predictable supply of wood to

the industries currently dependent on the timber harvest from this unit? Properly specified alternatives in this case would be comprehensive plans for the management units and would include such elements as obtaining some wood from private land, importing some wood from other management units, and employing a mix of timber management practices depending on the soil types.

Finally, the description of the undertaking is incomplete. It ignores fire prevention and suppression. The agents responsible for different aspects of the undertaking are not specified. The procedures for allocating timber licences and selecting the location and size of FMUs are not described.

4.1.3. The RATIONALE FOR THE UNDERTAKING is based upon inappropriate data; no rationale is provided for alternatives to the undertaking and alternative methods for carrying out the undertaking.

The Class Environmental Assessment document does not provide a rationale for the alternatives to the undertaking, nor does it provide rationales for the alternative methods for carrying out the undertaking.

There are two important elements of the rationale for the undertaking given in the Class Environmental Assessment document: the importance of the forest products industry to the provincial

economy and the anticipated increase in industrial demand for wood.

On the first point, the document suggests that:

the forest products industry is vital to the economic and social well-being of the province, in particular northern Ontario with its numerous forest industry-dependent communities (p.29).

The document goes on to describe the industries' "major contribution" to the economy, its ability to generate "...substantial export earnings and [offer] the potential for considerably more", the "large taxation revenues", and the provision of "well-paid employment for large numbers of people". Most of the statistics to support these claims are given in an earlier section of the document (7.1.1.).

On the assumption that the same data are meant to apply to this section, the data are inappropriate to evaluate the importance of timber management to the economy. They apply to a gross contribution, rather than a net contribution. Negative impacts are ignored. They apply to all the timber-based industries, rather than just the logging industry. If all of the timber-based industries are supposed to be part of the analytical framework, then to be consistent, the environmental impacts of the lumber and pulp and paper industries, for example, should be considered. The evidence suggests that the dependence of several northern Ontario communities on the timber-based industries may actually

be detrimental. Many of these points are developed more fully in Section 6 of this report.

The second element of the rationale is that "Industrial demand for wood is expected to increase." (p.29). No quantitative support is provided for this statement. Instead, the assertions are made that the demand for fibre for the pulp and paper industry is expected to rise and that "...export demands from countries with inadequate timber resources..."(p.29) will increase. It is not clear what the relationship of these assertions is to the demand for fibre from Ontario's forests. In particular, Ontario is reasonably well located to provide exports to only one country, the United States. This is reflected in the distribution of exports discussed in Section 6. The United States could not be classified as a country with "inadequate timber resources"; it has substantial resources, a very large industrial capacity, and may become self-sufficient in timber production in the near future.

In any case, the demand for fibre from Ontario's forests will be reduced if costs rise as a result of "increasingly remote" timber supplies. Increased production from more intensive management or even the provision of "a continuous [in the sense of approximately constant] supply of raw material" (p.30) is only justified if the net benefits of such management are positive. These benefits include not only the net value of timber

production, but also the net changes in the value of the other forest-based goods and services.

4.1.4. The provision made for DESCRIPTION OF THE ENVIRONMENT AFFECTED is inadequate.

The Class EA document asserts that the description of the environment affected is part of the timber management planning process, and as such need not be described for the Class Environmental Assessment. In the timber management planning process, the planning team is responsible for assembling the appropriate background information. In some cases, additional data will be collected so that "other resource features, land uses and values" may be considered.

No attempt appears to have been made to specify which values will be assessed nor which aspects of the environment must be adequately described before timber management can begin. There is no indication of what procedure should be followed if the description is inadequate and the time required to do a proper job would slow or prevent harvesting.

4.1.5. No standards are set for the DESCRIPTION OF ENVIRONMENTAL EFFECTS at the FMU level.

The description of environmental effects consists of isolating

each of the elements of timber management (provision of access, harvest, renewal, and maintenance) and discussing the effect of the alternative methods for carrying out each. The environment is divided into aquatic, terrestrial, and socio-economic-cultural components.

The description is primarily in qualitative terms with sporadic use of quantitative information. There is no ranking of effects in terms of potential importance. Financial costs for the different activities are not always provided; financial benefits are not listed at all. The chief benefits of timber management supposedly arise through their:

considerable positive effects on the socio-economic environment, such as opportunities for direct and indirect employment, provision of wood and wood products to commercial markets, generation of revenues, and contribution to community stability (p.56).

A similar emphasis on the provision of wood to markets and on employment and their indirect economic effects occurs elsewhere (p.82, OMNR, 1987b).

As discussed above, none of the effects listed qualifies as a net economic benefit. The only one that comes close is "generation of revenues", yet the costs of producing the revenues are apparently ignored. For the last effect, no evidence is presented.

At a minimum, the Class Environmental Assessment should set standards for the kind of quantitative information to be used in decision-making and should incorporate an analysis of net benefits (if any).

4.1.6. The description of PREVENTATIVE AND MITIGATIVE ACTIONS does not reflect the need to maximize the net benefits for all users of the forest.

The actions "to prevent, change, mitigate or remedy" the environmental effects are described in the Class Environmental Assessment document as follows:

Most negative environmental effects can be prevented or minimized through proper planning and implementation of timber management operations, or mitigated through application of effective remedial measures. Some residual negative effects will have to be accepted as the inevitable consequences of the timber management undertaking.... there are a variety of manuals which provide direction for the implementation of timber management operations. These manuals describe actions which can be taken in varying situations to prevent, minimize or mitigate the effects of certain timber management activities on the environment (p.56-57).

The description is vague and platitudinous. The only actions detailed in the Class Environmental Assessment are establishment of reserves and modified management areas in which a "comprehensive planning process" will be performed.

The only basis for this decision to implement one or more of the mitigative actions appears to be the judgement of the forest

manager. Yet the forest manager has a limited and biased viewpoint; he or she is not managing all the forest resources for maximum social benefit. The element of judgement is reflected in the line that apparently must be drawn between "most negative environmental effects" and "some residual negative effects".

No procedure is specified for the choice among remedial actions, let alone basing a decision on economic efficiency grounds. (For example, the issue of compensation of other forest users is not discussed.) The effects (economic and otherwise) of the actions that might be taken are not described.

Finally, the resource manuals "which provide direction" are incomplete (in that not all values and uses of forested land are represented) and their use is not required by the EA document.

4.1.7. The EVALUATION OF ADVANTAGES AND DISADVANTAGES is inadequate.

The "evaluation of the advantages and disadvantages to the environment" is probably the most important aspect of environmental assessment. The various effects and concerns should be weighed in a systematic and objective fashion to produce the justification for the undertaking as it is proposed.

The evaluation section in the Class Environmental Assessment

document (sections 7.1 and 7.2) consists of a description of the undertaking and the two alternatives to the undertaking previously discussed and their ability to meet several criteria. The criteria are almost exclusively socio-economic, ranging over employment, tax revenue, export revenue, previous government investments (considered as a benefit!), maintenance of the current forest industry, security and predictability of wood supply, anticipated expenditures by government to buffer and compensate for economic and employment losses. Most of these are described in qualitative terms or in quantitative terms only at the provincial level. The comparison and evaluation consists of a table in which the ability of the three options to meet the criteria is presented in qualitative terms, in some cases without any justification in the text. The most important criterion is presumably the continuity and predictability of supply.

4.1.7.1. It is not related to the net social benefit of the undertaking.

This evaluation is seriously deficient. No conclusion is reached from the comparison; the choice of status quo timber management is only implied. No justification is given for the choice of criteria; a different set would give a different result. (As discussed above, a preferred criterion would be economic efficiency. This objective has been sufficiently justified in the economics literature.) The implied use of the statement of

purpose to evaluate the alternatives suffers from the ambiguity inherent in the statement of purpose. In many cases, the criteria used are not compatible with an objective of maximizing net social benefits. There are no means suggested for weighting the different criteria.

4.1.7.2. It fails to evaluate alternatives at the FMU level.

As discussed above, the alternatives examined are inappropriate. Consideration of alternatives at a provincial, rather than FMU level might be the outcome of readily available statistics at the former level. If similar statistics are unavailable at a FMU level, this lack of information will present a serious obstacle to an adequate evaluation.

4.1.7.3. It is inconsistent in its coverage of the forest industry.

The consequences of each alternative, including the undertaking, are improperly specified. The economic contribution of the wood industries and paper and allied industries is attributed to timber management, when these industries are actually indirect consumers of the output of timber management. There is often a connection between timber harvesting and papermaking in that the same or closely related companies may carry out both activities, but there is a logical distinction. The choice of indirect

effects is inconsistent. Including the pulp and paper industry in the economic analysis means that the environmental impacts (e.g. pollution) of pulp mills should also be included. None of the industries negatively affected by timber management is identified or discussed in this section. Finally, the discussion is placed at the provincial level, rather than at the FMU level where it belongs.

4.1.7.4. The evaluation procedures described elsewhere in the EA document are also deficient.

Evaluation procedures are described elsewhere in the Class Environmental Assessment document. First, in discussing each of the activities of timber management, decisions with respect to management objectives, methods, and locations are described. These decisions are usually to be made by considering some of the factors in a list. The ambiguity and the scope for discretion do not inspire confidence that environmental concerns will be adequately protected. See Section 3 of this document for further comments on evaluation procedures for specific activities.

Second, evaluation is also called for in the so-called "comprehensive planning procedure" which is invoked when operations or roads are potentially to take place in areas of concern. Yet here is a matter of "judgement" in a situation in which there is no incentive to manage for joint production of

goods and services, and the information to do so is inadequate. In addition, under these circumstances, it is only necessary to consider and justify one course of action. According to this procedure, it is not necessary to evaluate the no-development option or to evaluate the "abandonment" option periodically.

The evaluation procedures may not be carried out in as thoroughgoing a way as possible if it is believed that the "bump up" to an individual environmental assessment will be a safeguard against flagrant environmental abuses. Some of the problems with the use of public participation to arrive at economically efficient decisions are discussed above.

4.2. In addition, the analysis in the Class EA reveals major conceptual weaknesses.

The problems raised previously may be grouped into six fundamental criticisms of the Class Environmental Assessment document.

4.2.1. The Class Environmental Assessment document interprets the role of the Class Environmental Assessment in a manner inconsistent with the spirit of the Environmental Assessment Act.

The Class Environmental Assessment document treats timber

management as if it were a single project. For example, it states (p.16) that the purpose of the undertaking, the rationale for the undertaking and alternatives to the undertaking are the same for all management units. Chapter 6 of the document considers only alternatives to timber management at the provincial level. The alternatives to the undertaking are described without any indication that the preferred alternative might vary from FMU to FMU (p.18-19).

We believe this demonstrates a clear misunderstanding of the spirit of the Environmental Assessment Act. A Class Environmental Assessment should not be viewed as an environmental assessment of a single undertaking. It should be an assessment of a process which systematically considers alternatives for each project falling into the class. The discussion of the common planning process in Chapter 5 of the document should emphasize that the goal of the process is to identify and evaluate alternatives during the preparation of management plans for each FMU.

Our interpretation of the appropriate nature of a class environmental assessment is supported by the 17 January, 1990 ruling of the Environmental Assessment Board, in which the Board found that the undertaking should be characterized as a "Timber Management proposal, plan or program in respect of the activities of harvest, renewal and maintenance".

4.2.2. The planning process described in the Class Environmental Assessment document fails to ensure that all important alternatives, including the null alternative of not managing for timber supply, will be considered at the level of the forest management unit.

For example, in the discussion of access roads (p.6; Appendix II, p.1) the alternative of no road at all is not considered. Similarly, the discussion of selecting management strategies (p.21) ignores the null alternative of no wood supply from the unit.

4.2.3. The Class Environmental Assessment document frequently ignores or underestimates the effect of timber management on non-timber activities.

For example, the summary description of regeneration (Summary, p.10) states that regeneration "reduces or reverses many of the potential adverse effects of harvest operations." This does not recognize that some forms of regeneration (e.g. using prescribed burning) may reduce the aesthetic or recreational appeal of forest land, thus exacerbating the negative effects usually associated with logging. Similarly (p.45), there is no discussion of the effects of various regeneration methods on non-timber uses of the forest. Some of these negative effects are acknowledged later in the report. It is surprising that such an

important caveat is missing from the summary.

Similarly, the description of Step Two of the timber management process (Summary, p.14), which is supposed to be determining the management direction for a management unit, makes no mention of non-timber uses. Likewise, the discussion of selecting a silvicultural system (p.122) makes no mention of the needs of other users of the forest. Finally, the discussion of access roads (p.65) does not recognize the "loss of wilderness" experienced when roads enter areas previously accessible only by canoes and aircraft.

4.2.4. The Class Environmental Assessment document generally fails to acknowledge difficulties created by the public goods nature of many forest services and the lack of bargaining power for certain groups.

The Class Environmental Assessment document recognizes that the "interests and concerns" of other users of the forest should be a factor in choosing alternative methods for timber management (p.31). But nowhere in the document is there a recognition of the fact that some uses of the forest are public goods (see glossary) which accrue to a wide variety of individuals who face high costs in organizing to make their views known. This is particularly true of recreational and non-participatory uses of the forest. It is well known that ordinary markets will fail to

make adequate provision for these uses because they cannot be bought and sold in the ordinary way and because it is difficult and costly for all users of recreational or non-participatory services to band together to negotiate compensation. Furthermore, lack of property rights to wilderness or forest diversity means that those who enjoy such aspects of the forest have little bargaining power. In short, there is bound to be market failure in the provision of non-timber uses of the forest. When markets fail, land will not be allocated in a manner satisfactory to everyone and conflicts will arise. The Class EA fails to recognize this.

Thus, for example, the text which commits the government to "consult" with native people (p.7, line 33), ignores the basic issue that consultation means very little when the persons being consulted have no bargaining power. Similarly, the discussion of social and cultural effects of access (p.67) ignores the problems of conflict in land use arising from the problems of market failure just noted. It makes no mention of wilderness congestion. Finally, the discussion of public review (pp.159,162; Appendix III, p.9) stresses opportunities for public participation, but provides no guidance for resolving conflicts of opinion and ignores the needs of dispersed and distant users of the forest.

4.2.5 The process described in the Class Environmental Assessment document pays insufficient attention to the contribution that can be made by the price system.

Timber management is described as a sequence of activities (p.9). This emphasizes that a central problem is to avoid sub-optimization - that is, attempts to carry on each activity as efficiently as possible should not detract from achieving the overall objective. Normally we rely on the price system to guide decisions - each activity should be expanded if it makes a profit when costs and benefits are valued appropriately. However there seems to be very little use made of the price system in coordinating the sub-activities of timber management. Thus the choice between alternative methods of carrying out the undertaking is to be based on the following factors:

- the characteristics of the forest ...;
- the site conditions, such as soil type and depth, slope and drainage;
- relative costs of alternative methods; and
- interests and concerns of other users of the forest.

(p.31).

Notice that although the relative costs of alternative methods are to be considered the benefit relative to the cost is not. In other words, the option of not managing for timber production because the revenues earned are less than the cost of management

is not systematically considered.

The Forest Production Policy (described on p.100) seems to ensure that there will be no calculation of marginal costs and benefits at the level of the management unit. Wood supply requirements are considered independently of price (p.119). This forecloses consideration of cases in which alternative uses are more valuable than wood supply.

The discussion of determining the significance of the effects of timber management in Areas of Concern (Appendix I, p.4) does not provide any method of amalgamating the results. This is where a social cost-benefit framework is essential. Finally, there is no requirement to compare the economic gains from protection operations to the cost of treatment (Appendix III, p.13).

4.2.6. The economic analysis in the Class Environmental Assessment is minimal and faulty.

There is very little economic analysis in the Class Environmental Assessment. What little appears is often faulty. For example, the analysis of the "do-nothing" alternative (p.23-24) is unacceptable. It presumes that the labour and capital employed in timber harvesting, processing, and renewal has no alternative uses. Since they manifestly do have alternative uses, the only relevant losses are the difference between the earnings of these

inputs in their best alternative occupation, plus some allowance for adjustment costs. Note that the discussion of alternatives to the undertaking has been entirely devoid of quantitative evidence.

The analysis of the "harvest with no renewal option" (pp.25-27) is equally unacceptable. The costs to the economy are described (lines 10 to 21) without any reference to the benefits of realizing the timber value of the forest sooner rather than later. The possibility of no harvest from marginal lands is not being seriously considered (p.27, lines 8-13).

Similarly, the argument (p.30) that increased production of timber from Ontario forests is required to meet the growing demand for wood is not compelling. If the cost of producing wood products domestically exceeds that of importing them, total consumption in the economy can be increased by allowing the industry to decline.

The Class Environmental Assessment document shows a fundamental misunderstanding of socio-economic effects (e.g. p.56, lines 30-34). Opportunities for employment, provision of wood and wood products, "generation of revenues", etc. are not necessarily "positive". They are positive only if the earnings of the labour are greater in forestry than in available occupations elsewhere and if the wood products are provided more cheaply (given

appropriate prices) than similar products produced elsewhere. Reference to multiplier effects (p.82) shows a disregard for the fact that long run multipliers can be much less than one.

The suggestion that considerations of maintaining employment should be fundamental to determining the response to a proposed amendment (p.172) invites abuse. Almost any project or change could be justified on these grounds. Finally, the discussion of monitoring (p.95) ignores any possibility of fines or subsidies designed to increase compliance at the margin.

5. A BETTER PLANNING PROCESS

This section argues that effective multiple use management of the forest estate requires a systematic evaluation of the costs and benefits of alternative forest management options. The natural environment would be better protected, and the aims of the Environmental Assessment Act would be better achieved, if social cost benefit analyses of alternative forest management schemes were required as part of the timber management process. A simple case study of a hypothetical forest management unit demonstrates that such analysis is feasible and suggests that modified harvesting combined with natural regeneration may be the economically preferred management option in some circumstances.

5.1 The Nature of Cost Benefit Analysis

Cost benefit analysis is primarily a method of organizing information about an undertaking so as to guide the selection of the best alternative.

Cost benefit analysis (CBA) is a scheme for systematically analyzing the advantages and disadvantages of undertaking a project when compared to its alternatives. CBA is a well-established procedure on which many texts have been written, for example Dasgupta and Pearce (1972), Sugden and Williams (1978), Pearce and Nash (1981) and which continues to be treated in modern texts on environmental and natural resource economics (e.g.. Common, 1988).

Cost benefit analysis is similar to the financial analysis of a project from the point of view of an individual company in that both forms of analysis compute the net present value of a project compared to a null alternative. In financial analysis, however, the costs and benefits are considered only from the point of view of the company or public agency conducting the accounting. In cost benefit analysis an attempt is made to count all costs and benefits, regardless of who bears them (Sugden and Williams, 1978).

The modern treatment of the theory of cost benefit analysis is mathematically complex. In practice however the main advantage of cost benefit analysis may simply be to force decision-makers

to:

list all gains and losses and to weigh up their relative values. This may seem a small virtue. But in a world where decisions are made more often than not on irrational assessments, it could remain the single most important attribute of any calculus designed to assist the decision-making process" (Pearce and Nash, 1983, 4).

5.1.1 The steps in cost benefit analysis include (a) defining the project, (b) specifying alternatives, (c) predicting impacts, and (d) valuing impacts. These are essentially the same as required under the EA Act.

Common (1988, 270) identifies 5 basic elements to a cost benefit analysis:

- i. Project definition and identification
- ii. Complete enumeration of the consequences of going ahead with the project.
- iii. Aggregation of consequences at each time period in the project's life to get time series for project costs and benefits.
- iv. Aggregation of the cost and benefit streams over time to get a figure for the project's net present value
- v. Sensitivity analysis [to see whether conclusions are sensitive to changes in assumptions.]

These steps are essentially those required in an Environmental Assessment under the EA Act. Common's step (i) includes the description of an undertaking, its alternatives, and alternative methods of carrying it out that are required in the EA Act.

Common's step (ii) corresponds to the description of the effects of the undertaking and its alternatives required in section 5(c) of the EA Act, and Common's steps (iii) and (iv) correspond to the evaluation requirements of section 5(d) of the EA Act.

Common's fifth requirement, analyzing the sensitivity of conclusions to critical assumptions is not made explicit in the EA Act but it is a matter of good practice and common sense. Essentially it requires that the main calculations be repeated for alternative assumptions about such important variables as the prices of key outputs and the rate of interest.

5.1.2 CBA usually assumes an objective of maximization of present value of net social benefit, but this is not necessary.

Cost benefit analysis is simply a formalized attempt to choose the course of action which best meets some objective. Thus a clear objective must be specified before CBA can be used. Most commonly the objective is to maximize net social benefits as described in section II of this document. As noted there, maximization of net social benefit is equivalent to maximizing national income after accounting for the value of non-marketed goods and services and other deficiencies in the conventional national income accounts.

Maximization of net social benefits (i.e. national income) ignores the distribution of income among citizens. That is, a loss of \$10 million to one group of citizens can be more than offset by a gain of (say) \$11 million to another group. If this is unsatisfactory, an alternative objective can be specified.

For example, the objective might be to maximize the weighted sum of the value of consumption by various income groups, giving larger weights to those with lower income (e.g. Harou, 1982; Pearce and Nash, 1983, ch 3).

Net social benefits are usually measured by "willingness to pay". As noted in section II, market prices are not always good indicators of willingness to pay. Social willingness to pay can also be inferred from collective decisions made through the political process. For example, the public may support occupational health and safety measures even with the knowledge that measured costs may rise and that their measured incomes may be reduced as a result. This implies a clear social willingness to pay for occupational health and safety.

5.1.3 There is no one correct way to conduct a CBA; rather there are a variety of approaches running from very simple to very sophisticated.

At the simplest level, a cost benefit analysis can compare the costs and benefits of two or more highly simplified scenarios, using rough estimates of the quantitative impacts of a project and of the value to be placed on these. Further refinement can come in several ways. Efforts can be devoted to obtaining better estimates of the unit value of various costs and benefits. For example, econometric estimates of the willingness to pay for

wilderness recreation can be prepared. The description (or "model") of the project and its alternatives can become increasingly complex. For example, the species composition and topography of a forest management unit may be considered. Finally, efforts can be devoted to optimize the projects chosen for comparison. For example, linear programming techniques can be used to choose the least cost harvest and roadbuilding schedule for a forest management unit.

5.1.4 The informational costs of a sophisticated CBA may be very high, but valuable information can be gained from preparing even a simple CBA.

As cost benefit analyses become increasingly more complex it becomes increasingly difficult and expensive to obtain the necessary information. It may also be harder to reach agreement on the values for various parameters and it may be difficult to interpret the detailed results. Such criticisms have been made of the application of complicated computer models such as FORPLAN to cost benefit analysis. This indicates that there may be an optimal scale for conducting CBAs. This scale would occur when the cost of extra refinement exceeded the value of more precise results.

On the other hand, the discipline involved in setting up the simplest of CBAs is remarkably effective in focusing attention on the key issues of project selection and in identifying areas where disputes must be resolved or further information obtained.

5.2 Application of Cost Benefit Analysis to Forest Management

It is entirely feasible to conduct simple cost benefit analyses of forest management in Ontario.

5.2.1 CBA should be conducted at the FMU level

In principle, cost benefit analyses can be carried out at the scale of individual stands, the Forest Management Unit, or the province as a whole. Since the entire timber management planning process is conducted at the level of the Forest Management Unit, it seems clear that CBAs should be also be conducted at this level. This is appropriate for least two reasons.

5.2.1.1 The stand level is too small to accommodate all the interactions amongst users.

First, many non-timber uses of the forest are affected by developments in many stands. For example, wildlife habitat may depend on the interaction of different forest types, and wilderness recreation may be adversely affected by new roads. Conducting CBA at the level of the stand tends to downplay these important interactions.

5.2.1.2 The provincial level combines too many essentially independent problems.

On the other hand, conducting CBAs of forest management at the provincial level ignores the fact that the definition of alternatives and the choice of appropriate projects will vary among FMUs. The analysis will either ignore these differences or

become very complicated.

5.2.1.3 Analysis at the FMU level must still account for important interactions at the provincial level, for example, the amount of wilderness recreational land remaining in the province.

Nevertheless, when cost benefit analyses are conducted at the FMU level, account must be taken of the effect of local decisions on the supply of forest services to the province. This is particularly important when valuing items such as maintaining old growth forest and wilderness recreation. The value of these items will be very much higher if they are scarce at the provincial level.

5.2.2 A CBA should continually attempt to treat all uses of the forest - timber, recreational and non-participatory - on an equal footing and to treat the costs and benefits accruing to all parties equally.

Cost benefit analyses are distinguished from financial analyses by their attempt to evaluate the consequences of a project for everyone who might be affected. Consequently it is important to consider all uses of the forest and all parties who may be affected by timber management.

5.2.3 Sophisticated CBA can be implemented using linear programming models such as FORPLAN, but this may be very expensive.

As noted above, elaborate management tools exist which can be applied to the calculation of the net social benefit of a project and its alternatives, but the use of such tools may be inappropriate if the expense of gathering and processing the required information is too great. Consequently we recommend beginning with a very simple cost benefit model and refining it where necessary.

5.3 Example of a simple Cost Benefit Analysis

This section illustrates the application of simple cost benefit techniques to forest management.

5.3.1 The purpose of the example is to illustrate a practical method for conducting simple cost benefit studies, and to demonstrate that, under reasonable assumptions, modified cutting with enhanced natural regeneration may maximize the NPV of the forest.

The purpose of the example is to illustrate a practical method for conducting simple cost benefit studies. We focus on the choice of harvesting and silvicultural technique in a forest

management unit. A second purpose of the example is to investigate the conditions under which a policy of modified harvest technique combined with natural regeneration may lead to higher net social benefits than current practice.

5.3.2 The undertaking is to manage a hypothetical FMU for maximum net social benefit.

In constructing our example we have assumed a forest management unit with a total area of 490000 ha, located 100 km from a pulp mill. The area contains large stands of conifer (black spruce). The standing timber is assumed to yield 130 m³ of merchantable wood if be used for timber. The forest may also be used for hunting and fishing, for non-consumptive recreation such as canoeing and hiking, or for some combination of these. In any actual case special note would be taken of the presence of rare or endangered species, the presence of significant old growth stands, and any other special ecological characteristics of the area. As in the case of the Class Environmental Assessment of Timber Management on Crown Lands in Ontario, the undertaking is to use a public authority to manage wildlife, harvesting, silviculture, road access and recreational opportunities to maximize the NPV of social benefits yielded by the forest.

In constructing our example we have tried to choose realistic values for the important parameters. We recognize that in any

actual application the required data would be site specific and possibly proprietary. We submit, however, that it would be entirely practical to generate the information required in any actual case.

5.3.3 The alternatives to be considered are (A) management for non-timber values only, (B) modified cutting with enhanced natural regeneration, (C) clear cutting with artificial regeneration, and (D) clear cutting with natural regeneration. Alternative (B) has two variants: B1 - a three-coupe system and B2 - a two coupe system.

In this framework, it seems somewhat artificial to consider alternatives to the undertaking. Strictly speaking, the main alternative to public management of the FMU is the outright sale of land to timber companies and cottagers and complete abandonment of regulation. We shall not consider these further in our example.

We are chiefly interested in choosing among alternative ways of conducting the undertaking. For the purpose of illustration we focus on the choice of timber harvesting and silvicultural method. Four broad alternatives will be considered. These are summarized in Table 1 and discussed below.

It is immediately obvious that many variants of each broad option would be possible. Moreover, combinations of differing options on differing areas of the FMU might yield a higher NPV than any single option. Such decisions would depend on the specific characteristics of individual sites.

5.3.3.1 Alternative A - No Harvest

Under this alternative the forest is managed strictly for non-timber uses. It is assumed that no timber will be harvested and there will be no silvicultural investments. No protection against fire or insects is undertaken. We assume current levels of management for non-timber uses. To illustrate the importance of non-timber, participatory uses we assume 1000 visitor-days of use from hunters and fishermen, 500 visitor-days of use from non-consumptive recreational users relying on road access, and 1000 visitor days of use from non-consumptive wilderness recreation. For the purpose of our example, these uses are assumed constant over time, although increasing incomes and populations might realistically lead to increasing recreational use over time. A minimal labour cost of \$50,000 per year is required to administer the non-timber uses. We stress that these assumptions are made only to indicate the nature of information that would be required for actual applications.

Alternative A would also yield maximum retention of the

ecological, hydrological and scientific benefits of undisturbed older growth forest.

5.3.3.2 Alternative B - Modified Harvest

Under this alternative the forest is managed for both timber and non-timber uses. Timber management is designed to enhance ecological values. Timber harvesting is confined to strips and blocks sufficiently small to ensure natural regeneration from surrounding trees. No artificial regeneration procedures are carried out. No herbicidal spraying is used, but the area is protected against fire and insect infestations.

Within this category we consider two variants:

Alternative B1 - Three-coupe Modified Harvest

In this variant (described in FFT Witness Statement No.5) the standing forest is cutover in three passes. A first cut removes trees in strips and blocks sufficiently small for natural regeneration. It is assumed a return cut is made after 10 years. Natural regeneration is supplied by the surrounding mature and ten year old trees. A second return cut is made after another 10 years. By this time the surrounding 10 and 20 year old forest provides natural regeneration. This variant is ecological preferred for the reasons given in FFT Witness Statement Nos. 1, 3, and 5.

Alternative B2 - Two-coupe Modified Harvest:

In this variant, again described in FFT Witness Statement No. 5, the forest is cut over in two passes with 10 year leave period. It is assumed that natural regeneration can be relied on for both cuts.

Both Alternatives B1 and B2 are assumed to lead to an even aged second growth forest with a rotation of 100 years and yield of 130 m³/ha. A constant volume constraint is imposed on both alternatives. That is, volumes of wood are not permitted to decline over the first or subsequent rotations. Thus the allowable cut under both rotations is 130/100 or 1.3 m³/ha when averaged over the entire FMU. Note that this does not mimic the current MAD formula used in Ontario, nor does it account for growth or decline in the standing timber. Moreover, a constant harvest volume is unlikely to maximize the NPV of timber benefits because market conditions will change over time. A more elaborate calculation would take these factors into account.

Compared with Alternative A (No Harvest) the modified harvest alternative B exhibits increased inputs of capital and labour for road construction and harvesting. No inputs are required for silviculture. There may be a significant increase in wildlife due to edge effects. No explicit account has been taken of timber loss due to blowdowns. Construction of roads provides

access for hunters and fishermen is improved: this is reflected in an increase of visitor-days from 1000 to 2000. To illustrate that access for some non-consumptive recreational uses will be increased we have assumed an increase to 1000 visitor-days.

While the number of visitor-days of wilderness recreation may increase, the roads and enhanced congestion will reduce the value of wilderness recreation services of the forest. The increase in non-timber uses will entail some increase in the costs of recreation management.

5.3.3.3 Alternative C - Clearcut/Artificial Regeneration

This alternative is intended to approximate current harvesting practices in Ontario. Non-timber uses are permitted, but no special action is taken to enhance them. Timber is clearcut in large blocks. Artificial regeneration is conducted by scarification of the site, planting, and two applications of herbicidal sprays. Despite the evidence indicating that some current harvesting practices reduce the productivity of the forest (FFT Witness Statements No. 1, 3), it is assumed for these calculations that this intensive management strategy will raise yields by 50% over natural conditions, to 195 m³/ha on an 80 year rotation.

Because the subsequent rotations will be shorter under assumption C, we assume that the allowable cut in the first rotation will be

higher under Alternative C than under Alternatives B1 and B2. In fact, we assume that the first harvest will be spread equally over 80 rather than 100 years. This acceleration of harvest is an example of the allowable cut effect (ACE). It is critically important for the results.

Compared with Alternative B, Alternative C requires a lower inventory of roads and hence harvesting costs will be lower. However silvicultural costs will be higher.

We assume that Alternatives B and C provide the same increased access to the forest for recreational use. Since edge effects will be less prevalent, however, we assume that the hunting and fishing experiences will be less valuable to participants. We also assume that clear cutting reduces the value of both road-based and wilderness non-consumptive recreation, .

5.3.3.4 Alternative D - Clearcut/Natural Regeneration

This alternative is chosen to illustrate the importance of the constant flow of timber assumptions in Alternatives B and C. In this alternative the forest is clearcut in large blocks at the same rate as under Alternative C (Clear Cut/Artificial Regeneration), but no artificial regeneration, spraying or protection to the new crop is given. Because no action has been taken to enhance natural regeneration, the resulting second

growth forest will differ in character from the first. We try to capture this by assuming that the second growth forest will not be worth cutting for 200 years and that even then the merchantable yield will be only 80% of the original level.

Alternative D provides the same road access as alternative C and consequently we assume that recreational visits increase. The naturally regenerated forest may be more suitable for a wide variety of wildlife, so the value of hunting, fishing and road-based non-consumptive recreation is assumed to be slightly greater than under Alternative C. Wilderness values have been just as effectively destroyed, however, so we assume the value of wilderness recreation is the same as under Alternative C.

Compared with Alternative B, Alternative D allows an accelerated harvest. Compared with both Alternatives B and C, Alternative D has much reduced silvicultural costs. However it violates the constraint that the annual supply of timber must not decrease. Such "mining" of the forest might also offend the sensibilities of many Canadians and foreigners. No attempt has been made to capture what these groups would be willing to pay to avoid such an outcome. Similarly, no attempt has been made to put a monetary value on the potential loss of plant and animal species due to clearcutting.

5.3.4 In the base case, only alternative A (No Harvest) has

positive net present value. The preferred ranking of the remaining alternatives is D (Clearcut/Natural Regeneration) (-\$43 million), C (Clearcut/Artificial Regeneration) (-\$44 million), and B (Modified Cut Natural Regeneration) (-\$48 million).

In principle, the detailed prediction of impacts precedes evaluation. For convenience of exposition, however, it is convenient to consider simultaneously both the impact and net benefits of the various alternatives. We consider the net benefits of the first harvest, subsequent harvests, recreation and other non-timber uses separately. In calculating these we subtract the cost of inputs which are reasonably attributed to specific outputs. We then consider certain activities which are not easily ascribed to individual outputs, such as the construction of certain roads and protection against fire and insects.

We begin with the analysis of the five alternatives under one set of basic assumptions.

5.3.4.1 General Assumptions

We assume the objective is to maximize the net social benefit generated by the forest. Present values will be calculated using a "real" social discount rate of 5% above the rate of inflation.

This is the lower bound of interest rates recommended by the Treasury Board of Canada (1966) for sensitivity testing, and several points below the social discount rate recommended by Burgess (1981). This eliminates the effect of varying price levels due to inflation. No allowance is made for changes in relative prices over time. In general, net social benefit will be measured by value of outputs less value of inputs. This requires the simplifying assumption that the outputs of this FMU are small relative to the total provision of forest services.

The unit value of timber produced in the forest is measured by the maximum price mills are willing to pay for delivered wood. The opportunity costs of labour and other inputs are assumed equal to their market prices.

The numerical assumptions are laid out in Table 1. Table 11 provides the data on which many of the assumptions were based.

5.3.4.2 Summary of Costs and Benefits

Table 2 summarizes the costs and benefits of the four alternatives under the assumptions of Table 1. For the given parameters Alternative (A) - no harvest at all - has the highest NPV, approximately 1.8 million dollars. All the remaining alternatives have a negative net present value because the costs of road construction, logging and haulage exceed the value of the

wood at the mill. This indicates that for the base case parameters the people of Ontario would be better off if this forest were dedicated to non-timber uses.

Table 2 also indicates the annualized equivalent of the NPV. This is simply the NPV multiplied by the social discount rate and it indicates the constant dollar annuity that would have the same present value of the forest estate.

For the given parameters the NPVs of alternatives B1 and B2 (three coupe and two coupe modified harvests respectively) are - \$54 million and -\$45 million, with annualized values of -\$2.6 million/a and -\$2.2 million/a respectively. This indicates roughly that the net income of Ontario residents would be reduced by \$2 million annually by the decision to manage the forest for timber values under Alternative B rather than leave it for non-timber uses as in Alternative A.

The loss from Alternative C (Clearcutting with Artificial Regeneration) is much greater: \$126 million or -6.3 million per year. This is because the artificial regeneration expenditures create a loss of almost \$80 million.

It is interesting to examine the NPV for Alternative D - Clear cut with no artificial regeneration. This alternative has a NPV of -\$46 million, or -\$2.3 million per year and is ranked between

the two- and three- coupe modified harvest schemes. This emphasizes how it is the artificial regeneration component of Alternative C that is economically inefficient.

Not all the costs and benefits of the alternatives have been evaluated. Table 2 also indicates the general effect of each alternative on several non-market values. The modified harvest methods B1 and B2 should promote wildlife volume and diversity, and should maintain the distribution of tree species. They would lead to the loss of old growth forests. Both would lead to a constant flow of timber. Note that no attempt has been made here to account for the environmental differences between B1 and B2. See Witness Statement No. 5 for details on this.

5.3.4.3 First Harvest

Estimates of the value of the first harvest are given in Table 3. Under alternative A, no timber is harvested. Alternatives B1, B2, and C reflect a constant flow of timber constraint. As noted above, the standing volume is assumed to be harvested in equal areas over 100 and 80 years respectively. These values equal the predicted rotation periods for subsequent harvests. Alternative D harvests the standing timber using current methods over a 80 year time span, thus generating the same benefit as alternative C, but no artificial regeneration is attempted. This alternative violates the even-flow sustained yield criterion. We

have assumed that another harvest will not be available from this land for 200 years.

The price at the mill assumed in the base case is \$25/m³, just slightly above current quotations for pulpwood delivered to mills in Thunder Bay. It will underestimate the true value of wood to the company if the latter is exercising market power to keep down pulpwood prices. Because the value of \$25/m³ leads to negative values of timber, we will assume a higher value of \$50/m³ for sensitivity tests to be conducted below.

The price at roadside is equal to the price at the mill less the costs of hauling timber to the mill. Obviously the distance to mill and cost of haulage are critical parameters in determining this value.

Logging costs are intended to include all the costs of harvesting timber exclusive of road building and transportation from roadside to mill. Again, these are critical to the calculation of net benefit. These costs would normally be available to forest companies and in an actual analysis, one would expect to have much better estimates of them.

The main difference among Alternatives B1, B2, and C occur in the construction of roads. Although ultimately the same length of road must be constructed, Alternatives B1 and B2 requires an

accelerated construction schedule during the first leave period. Table 13 indicates that this acceleration effectively raises the capital cost of tertiary roads by about 56%, given an 11 year leave period and 5% real discount rate. In addition, there would be increased maintenance costs on the increased inventory of active roads.

Note that Table 3 does not subtract primary and secondary road costs in calculating the net benefit of the first harvest. This is because one could argue that primary and secondary road costs contribute to other uses of the forest. It is also true that the a portion of secondary road costs are paid by the province rather than the forest company, and to this extent the net benefit in Table 3 approximates the private value of the harvest to the logging company. Primary and secondary road costs are computed in Table 6 and subtracted in Table 1.

5.3.4.4 Second and Subsequent Harvests

Table 4 calculates the value of the forest estate for future harvests, assuming one method will be used in perpetuity. It is assumed that Alternatives B1 and B2 (modified cutting with natural regeneration) yield $100/m^3$ on a 100 year rotation. Alternative C (clear cut, planting and tending) leads both to higher yields ($150 m^3/ha$) and a shorter rotation period. Alternative D (clear cut, natural regeneration, leads both to a

much longer rotation period (say 200 years) and lower merchantable yields ($80 \text{ m}^3/\text{ha}$). Under alternatives A, B, and D there are essentially no silvicultural expenses apart from harvesting costs. Under alternative C, silvicultural expenses include scarification, planting in the initial year of treatment, and aerial spraying in the 5 and 15th years. It is assumed that secondary and tertiary roads are entirely reconstructed to harvest each rotation, at a cost equal to the original construction.

There are three steps in the calculation:

1. Calculate the value of Net Social Benefit obtained per hectare of land per rotation, discounted to the beginning of the rotation, under alternatives B1, B2, C or D.
2. Adjust to obtain the present value of a perpetual stream of such harvests, discounted to the beginning of the second rotation.
3. Adjust to obtain the present value of subsequent harvests on the entire FMU, calculated as of the beginning of the first rotation (i.e. the initial harvest).

The net social benefit per ha per rotation is simply the value of

the harvest, discounted by the length of the rotation period, less the discounted costs of any silvicultural treatment.

(Note that since the first year of a rotation is denoted year 0 and not discounted, the last year of a 100 year rotation is denoted year 99 and discounted by $(1 + \text{social discount rate})$ raised to the 99th power.)

The present value of \$1 received every T years starting T years from now is $1/(1-i^T)$. This formula is used to perform step 2.

Under assumptions B1, B2, C, and D, the initial forest is harvested at a constant rate equal to the production forest divided by the rotation period. Thus for a 100 year rotation 1/100th of the production forest becomes available for the perpetual income stream calculated at step 2. Suppose the value calculated at step 2 is \$A. Then the present value (PV) of the future harvests on the FMU is the PV of \$A received for T years, beginning now, where T is the rotation period. Assuming the first years receipts are not discounted, the present value of this flow is $\$A \cdot (1-i^{(T-1)})/(1-i)$. This formula is applied in Step 3 of the calculation.

Given the parameters of the base case, Table 3 indicates that future harvests always have a negative net benefit. This is because under our base assumptions timber uses of the forest are less valuable than non-timber uses. Alternative D has essentially

a zero net benefit from future harvests. Alternatives B1 and B2 have significantly larger net losses because they involve more expensive harvesting methods. The present value of subsequent harvests under Alternative C is highly negative, indicating that provincial net income is substantially reduced by adopting this alternative. Recall that these estimates do not deduct secondary road costs. These are calculated in Table 6.

5.3.4.5 Recreation

Table 5 calculates the net benefit of recreational activity on the FMU under the five alternatives. Even more than in the previous cases, the numbers chosen are intended to illustrate a computational method rather than to reflect an actual situation. This is because willingness to pay for recreational sites may be highly site specific and the necessary data for an actual FMU were not available.

Research into the valuation of recreational activities has dramatically increased in the past decade. Bowes and Krutilla (1989, 6,7) provide a relatively accessible introduction to the basic ideas and the recent literature in the context of managing public forests. The key problem is inferring the public's willingness to pay for new recreational sites or improvements in existing sites. Some literature on this topic is summarized in an appendix to this document. Well established procedures have

been now developed and implemented to estimate the value of both of general activities such as fishing and scenic viewing and the specific value attached to certain recreational sites and areas. The two main approaches are to directly estimate willingness to pay from survey data (e.g. Cameron, 1988) or to infer willingness to pay from observed behaviour (the Travel Cost and Hedonic Price methods).

Willingness to pay for access to a specific recreational site or area will depend upon the quality of the site and the availability of substitutes. The question of substitutes is particularly important. If recreational activities such as hunting or motor boating are readily available nearby the areas and there is no problem of congestion, the unit value of a small addition to or subtraction from the available total may be very small. On the other hand, building roads into a previously unaccessed area may reduce by a large fraction the wilderness available to residents of a large population centre. The willingness to pay to preserve this specific area may be very high.

The numbers chosen for Table 5 illustrate these ideas. Three classes of visitor are hypothesized. Road access is assumed to increase the number of visitor days available but to reduce the quality of the recreational experience for visitors seeking wilderness experiences. Moreover, clearcutting is assumed to

reduce the value of the recreational experience for all classes of visitor. Management costs are assumed proportional to visitor days. The figures chosen are approximately equivalent to 2 to 4 full-time jobs at an annual salary of \$25,000.

Annual recreational benefits are assumed constant, although it is clear that most specific plans would provide a pattern of use that changed over time. Also, attempt has been made to model the argument that willingness to pay for recreation is likely to rise over time as populations and incomes increase and available substitutes decline. (cf. Krutilla and Fisher, The Economics of Natural Environments).

When the unit value of wood is low, as it is in the base case, the recreational benefits are positive while the timber benefits are negative. This indicates that Ontario can avoid the environmental costs of timber harvesting at no cost. This is consistent with the findings of Bowes and Krutilla who found that recreational values in the White Mountain National Forest in the USA "dwarf[ed] the value of timber even on productive sites", even when the relatively low value of US \$9.33/day (at 1981 prices) was used in the calculations.

5.3.4.6 Other Benefits

No valuation has been attempted of large and potentially

important benefits associated with the non-marketed ecological services provided by the forest. These are listed on Table 2 as Volume of Wildlife, Species Diversity, Loss of Species, Loss of Old Growth, and Non-decreasing flow of timber. In principle, one could conduct survey experiments to develop willingness to pay values for these items, but in practice data will almost always be missing. Our recommendation is that such Un-evaluated Benefits and Costs should always be tabulated and presented along with the summary of evaluated costs and benefits. One can then calculate how much the achievement of a given environmental objective would cost in foregone measured benefits.

For example, Table 2 indicates that Alternative A (no harvesting) has the highest present value. Alternative B2 has a present value \$46 million less than Alternative A. This might be viewed as the cost of obtaining the un-evaluated results of higher community employment, higher wildlife volumes and increased species diversity associated with Alternative B2 (But note the associated loss of wilderness values as well). Sometimes, however, many environmental objectives can be reached at a lower measured cost than current practice. For example, Alternative B2 costs \$82 million less in present value compared to C. Yet it is postulated to achieve higher environmental quality. This improved environmental quality is available essentially at no cost to society.

5.3.4.7 Primary and Secondary Road Costs

Table 7 presents the estimated value of secondary road costs.

Primary roads are assumed already present in the FMU.

Alternative B is assumed to require the same acceleration in road construction as was required for tertiary roads. The present value of road costs for the initial harvest is comparable in size to the net value of the initial harvest calculated in Table 3.

5.3.4.8 Protection

Fire protection costs of \$0.85/ha have been included. This equals the provincial average spending in 1989. Pending better estimates, insect protection costs have been included at a nominal value of \$.01/ha in the cases of alternatives B and C. This is the average MNR grant for spraying in 1989, expressed on a per ha basis. Under Alternative A no fire or insect protection expenditure is considered. Alternative D has fire protection but no insect protection. Table 7 shows the results of the calculation.

5.3.5 Sensitivity Tests on Annualized Timber Benefits show the ranking of alternatives is sensitive to the social discount rate, the price of wood at the mill, the productivity of the site, and the allowable cut effect.

Any cost benefit analysis should be subject to tests which examine the sensitivity of its conclusions to variations in its key parameters. With respect to the choice of harvest and silvicultural system the key variables are probably social discount rate, the price of wood at the roadside, the basic cost of road construction and the increase in road costs caused by the strip cutting system. To illustrate the type of sensitivity analysis that might be performed, Table 8 gives the sensitivity of the net present value estimates to changes in the social discount rate, the price of wood at the mill (this is obviously closely related to the unit value of wood at roadside,) and the productivity of the forest as measured by yield.

To focus on the choice of timber management techniques, all non-timber benefits have been excluded from the sensitivity analysis. We examine only annualized timber benefits, defined as the NPV of timber alone (line 5 of Table 2) multiplied by the social discount rate (line 8 of table 2). Moreover, so as to obtain positive timber benefits, in most tests we assume the price of wood is \$50/m³, double its base case value.

The present value of timber benefits is very sensitive to the initial harvest schedule. In fact, the main advantage of the clear cutting alternatives C and D are in the accelerated harvest they permit. This advantage is a form of the allowable cut effect (ACE). Because of the importance of the ACE, we report

sensitivity tests both with and without the ACE present. To remove the ACE, we assume that the clearcutting alternatives C and D are restricted to the same initial rotation of 100 years as assumed for B1 and B2.

5.3.5.1 With \$50/m³ wood, natural regeneration is preferred for moderate social discount rates. Artificial Regeneration is preferred only at very high or very low social discount rates. When the allowable cut effect (ACE) is removed, artificial regeneration is preferred only at very low discount rates.

In Table 8, panel (a), the social discount rate is varied from 1% to 11%. With the higher value of wood, alternative A is dominated by timber production. For interest rates of 3% and above the two-coupe modified cutting alternative B2 is always preferred to Clearcutting with artificial regeneration. The three-coupe method is preferred for social discount rates between 3% and 7%. At the extremely low interest rate of 1% clearcutting with artificial regeneration is preferred. This is because the high investments in intensive forestry can be financed at a very low interest rate.

Alternative D - large scale clearcutting with no artificial regeneration - dominates all the other alternatives. This indicates that the investments in regeneration required by the

sustained yield criterion reduces the measured value of timber benefits. Two important conclusions can be drawn. First, regeneration can still be justified if the value of the sustained yield criterion is higher than the additional cost it imposes. For example, Ontario might well be willing to pay the \$3.2 million annual difference between the timber costs of the ecologically preferred alternative B1 compared to the "mining" alternative D. Second, regeneration should be undertaken at least cost to society. Choosing the artificial regeneration alternative C sacrifices more social benefits than does the two-coupe natural regeneration alternative B2. Finally, since the return on regeneration investment is negative, we cannot expect private agents to pay much attention to it.

We have referred to the importance of the allowable cut effect. Panel (b) of Table 8 shows that if large scale clearcutting and artificial regeneration (Alternative C) is not granted an accelerated first harvest, it loses almost all its appeal. For all social discount rates above 1% Alternative C yields much lower net benefits than the modified harvest alternatives B1 and B2.

5.3.5.2 Natural regeneration is preferred when the value of wood is moderate or low. Given an allowable cut effect (ACE), artificial regeneration yields highest net timber benefits when the price of wood is high. This is not true if the ACE is removed.

In panels (c) and (d) of Table 8 the price of wood at the mill is varied from \$10/m³ to \$100/m³. The results indicate that once the ACE has been eliminated, the social choice of silvicultural system is not influenced by the price of wood relative to other costs. Similarly, panel (c) demonstrates that the choice of method is not sensitive to the natural productivity of the forest.

5.3.5.3 Natural regeneration is desirable on sites of low to moderate natural productivity. Given an allowable cut effect (ACE), artificial regeneration yields higher net timber benefits on plots of high natural productivity (assuming the percentage increase in yields from intensive management is constant). This is not true if the ACE is removed.

In Panel (e) of Table 8 the natural productivity of the site is varied from 75 m³/ha to 175 m³/ha. It is assumed for purposes of illustration that the productivity of intensively managed sites (Alternative C) will be 50% greater than the "natural" site

productivity and that the productivity of site subjected to large area clear cutting with no artificial regeneration will be 80% of the natural productivity. Given the parameters assumed, the timber benefits of artificial regeneration dominate natural regeneration only when the natural productivity of the site is 150 m³/ha or more.

Panel (f) of Table 8 shows that when all alternatives are restricted to the same 100 year initial rotation, the natural regeneration alternatives always yield larger timber benefits than the artificial regeneration alternative.

5.3.6 Conclusions

Readers are reminded that this example is hypothetical and intended primarily to illustrate a method of analysis that should form part of forest management. The data are not necessarily representative of any individual FMU. The sensitivity tests did not take non-marketed benefits into account. Nevertheless, several conclusions are worth emphasizing.

1. Simple cost benefit analyses are entirely practical at the level of the forest management unit. They should be undertaken if only to ensure that all alternatives, costs and benefits are considered during the preparation of a forest management plan.

2. Even when environmental factors are not considered, the choice of an appropriate silvicultural and harvesting system depends largely upon the price of wood at the mill, the discount rate, and the allowable cut effect.
3. Current values of wood are such that no harvest at all may well be the preferred option for some FMUs or some areas of some FMUs. In the absence of allowable cut effects, intensive management techniques such as planting and chemical tending can only be justified at unrealistically low rates of interest.
4. The Allowable Cut effect can make current artificial regeneration techniques attractive at high social discount rates. In these cases the value of second and subsequent harvests is negative.

6. Provincial Economic Issues in Timber Management

Introduction

Forest management is a site- or management unit-specific production process, with primarily local environmental impacts. Yet forest management is also embedded in a larger provincial context. It is at the provincial level that the aggregate effects of forest management may be identified in terms of the

net social benefits. It is also at the provincial level that political decisions establish the policies, regulations and spending programs which shape the context of forest management decisions. Finally, it is at the provincial level that it is easiest to identify the trends in supply and demand for various goods and services derived from forests. This section will consider each of these in turn.

6.1 Previous sections have demonstrated that cost benefit analysis can be successfully applied to evaluate alternatives at the FMU level. A similar analysis, based on net contribution to the economy rather than gross contribution, can be done at the provincial level.

The forest products industry has been classified by Statistics Canada into three major groups: forestry services (predominantly logging), wood industries, and paper and allied industries. Only the first of these groups is directly involved in forest management and might be considered a direct consumer of the output of timber management programs; the other two groups use wood as an input and thus are indirect consumers of the output of timber management.

Any contribution of the latter two industry groups to the provincial economy or to environmental problems (e.g. through pulp mill pollution of waterways) should be outside the scope of

the Class Environmental Assessment. Only the logging industry is directly related to the activities of timber management.

The proper evaluation of the contribution to the provincial economy should be done on a net, rather than gross, basis. Even on a gross basis, the logging industry makes a relatively small contribution to the provincial economy. There are a variety of possible measures of gross contribution. In 1985, the logging industry shipped goods with a value of \$949 million, produced a value-added of \$388 million, and generated corporate taxable income of \$17.2 million (Smyth and Campbell, 1987). This corresponds to a contribution to the province's gross domestic product of 0.3%.

(Very few data appear to be available on the value-added associated with other uses of the forest in Ontario nor do there appear to be good estimates of the magnitude of non-marketed values.)

Peterson et al. (1987) analyzed the components of net economic benefits, in an approach that parallels the use of CBA. They distinguish three accounts corresponding to the major economic groups which combine to produce national economic development (NED): the government account, the consumer account (or consumer's surplus), and the industry account (or net private revenue). For example, an increase in timber harvest might lead

to an increase in the industrial account (as a result of increased profits for the logging industry), no net change in the government account (increased taxation and stumpage revenue balanced by increased forest management expenditures), and a drop in the consumer account (loss of fishing habitat leading to a reduced willingness to pay for fishing opportunities). The combination of these accounts will determine the net effect of the increase in harvest.

6.2. Analysis of the net contribution of timber management suggests that it is having a net negative impact on the provincial economy of Ontario. A large net cost to the provincial government is not offset by industry revenue.

In Ontario, benefits from timber management accrue to both the provincial and federal governments. The federal government receives benefits through taxation of the logging industry. In 1984, this amounted to \$15.9 million (an increase from \$12.3 in 1983) (Statistics Canada, 1987). It is difficult to estimate the federal expenditures which are attributable to timber management in Ontario, as this would include, among other things, some fraction of the operating costs of federal research stations. One indication of the level of spending is that the federal portion of the COFDRA funds alone averaged \$15 million per year over the time span of the agreement.

In this analysis, it is important to include the opportunity costs of the inputs used to produce taxable income. Thus government revenues from industry in the form of corporate income tax are not a net social benefit (Lewis, 1976). For example, if another industry could employ the same capital and labour to produce a greater tax revenue, then there is a net social cost to using the productive factors in the first industry.

The provincial government receives revenue through stumpage (and related charges) and through corporate taxation. In Ontario in 1986-87, the MNR received \$86.2 million in timber revenue, most of it (\$64.1 million) in the form of stumpage. Timber area charges added another \$6.4 million (OMNR, 1987d). In the same year (1986-87), provincial expenditures on forest management were \$195.1 million. The negative balance of \$108.9 million contributed to the overall deficit in the MNR accounts. Total expenditures in 1986-87 were \$530.6 million and revenues were \$221.3 million (Ontario Ministry of Treasury and Economics, 1987), a difference of \$309.3 million. (Expenditures exceeded revenues in 1984 by a similar amount, \$291.1 million (OMNR, 1987d).)

In theory, the provincial government, as the owner of forested land, should obtain the economic rent from the harvest of timber. In practice, the Crown may be unable to capture all the rent if, for example, labour is employed at a wage greater than its

opportunity cost (Lewis, 1976). In addition, the chief means of capturing economic rent, stumpage fees, is used as a policy tool and is subject to political compromises. This is reflected in the recent changes to the stumpage system (effective July 1, 1988). The changes shifted the burden of fees from the lumber industry to the pulp and paper industry, largely because of the effect of the 15% softwood lumber export tax on the lumber industry. The Ministry's review also showed that "...the province's pulp and paper companies were making record profits, and could afford to pay more for the raw material." (Noble, 1988b, p.B4).

Some rent which is not captured through stumpage may be (imperfectly) obtained through corporate taxes. In 1984, the forest industries in Ontario (primarily logging) paid \$0.5 million in provincial corporate income tax (up from an amount less than \$0.1 million in 1983.)

In total, the figures strongly suggest that the provincial government is subsidizing timber management in Ontario. A more detailed analysis is required to evaluate this point conclusively. Analysis would include indirect benefits (after appropriate assessment of opportunity costs), economic rent passed on to the consumers of timber or captured by workers in the forest industry (that may be partially recovered through taxation), and the net change in the value of the province's

assets as a result of timber management activity (its ability to produce other goods and services).

The remaining two major economic groups, consumers and industry, consume various forest-derived goods or services. The consumer's account represents the change in willingness to pay for goods and services from the forest that are directly consumed and not always marketed, e.g. recreational activity. Data do not appear to be available to estimate this value well for Ontario as a whole. The net benefits to the second group of consumers, companies who use trees (as opposed to timber) as inputs, may be measured by economic profits. No data were located on the profitability of the logging industry in Ontario, although the relatively small amounts of corporate taxable income and tax paid suggest that profits were quite small.

In conclusion, while there are significant uncertainties in the accounting, the available data suggest that timber management activities are having a net negative effect on the provincial economy.

6.3. One justification for continued provincial government subsidization of timber management is its supposed contribution to regional development, and specifically, to stability of northern Ontario communities.

Sinclair (1987) summarized the historical role of forest exploitation in Ontario succinctly:

The forest resources of Northern Ontario were used to promote maximum investment and employment, with little regard for efficiency, long-term management of the forests themselves, or protection of the environment. The major purpose was to promote growth of manufacturing industry, based in this instance on the export of comparatively simple manufactured products to the American market. In order to attain these goals the Ontario government was willing to sacrifice revenues and enter into very close relationships with business interests (p.83).

The goal of provincial and regional economic development remains a central consideration for the provincial government.

Regional development aims to produce a viable and diverse economy capable of supporting a stable and relatively well-off population. In theory, the development of a region that is exploiting a single resource relies on the establishment and growth of economic linkages of various kinds: backward to build up the industry that provided inputs, forward to establish additional uses of the product, and induced which result from additional spending by consumers.

The focus on regional development and community stability is a

justification for programs such as the COFDRA, silvicultural programs, and road-building programs.

6.4. Forest industry activity may not contribute significantly to regional development.

Forest industry activity may not contribute significantly to regional development. Marchak (1983) argues that there is no necessary relationship between development of the forest industry and the development of a region. White et al. (1986) observed no trend towards diversification in the portion of rural British Columbia dependent on the forest sector.

The extent to which forest industries might contribute to regional development may be indicated by the proportion of their non-wood expenditures that are made within the province, an instance of backward linkages. The Timber Sales Branch of the OMNR (1981) estimated that in 1978, 52% of such goods and services were purchased from outside the province (including 15% imported to Canada). A similar estimate in British Columbia suggested that less than half of such expenditures were made in the province (F.L.C. Reed and Associates Ltd., 1975).

6.5. Employment in the forest industries is cyclic, and the long term trends are stagnant or declining. The decline is particularly obvious when the number of people employed per unit of wood harvested is assessed.

The critical determinant of the socioeconomic impact of timber management is the level of employment and the incomes resulting from that employment. This section will examine the trends in employment and the next section will discuss the relationship to community development and stability.

Evidence presented by industry and MNR panels (MNR Panel 5, Industry Panels 1 and 2) has clearly demonstrated that in the short-term employment levels in the forest industries are cyclic. The timing and magnitude of the cycle is largely determined by the business cycle in the United States.

With respect to the long-term trends, employment in the forest sector in Ontario has been relatively constant or declining, depending on the industry and time frame considered. Despite an increase in primary forest production from 17.3 million m³ in 1972 to 28.1 million m³ in 1984, employment in all the forest industries (as defined by Statistics Canada) only increased from 71 thousand in 1972 to 72 thousand in 1984 (Smyth and Campbell, 1987). Thus the number of jobs per thousand m³ harvested dropped from 4.1 in 1972 to 2.6 in 1984. This is largely a function of

increased productivity through mechanization.

The decline in employment in the Ontario forest sector is likely to continue for the near future (Ontario Ministry of Industry, Trade and Technology, 1986). The decline in employment levels will be exacerbated by any slowing in the rate of increase in harvest. When the projected timber supply "falldown" occurs, employment in the forest industry will drop even further.

Perhaps the most striking indication of these employment trends is seen Tables 9.10 and 9.11 of Smyth and Campbell (1987). For all of northern Ontario, the population dropped by 3.2% between 1981 and 1986. This contrasts with the increase observed for southern Ontario of 5.7%. The drop in northern Ontario occurred in almost all districts and almost all communities. These data are inconsistent with any notion of community stability.

6.6. The relatively high incomes in forest industries are not an accurate reflection of quality of life. The increase in wages over time has not kept pace with the increase in productivity. As a result, the contribution to community payrolls per unit volume of wood harvested has dropped.

Industry evidence (especially Panel 2) has repeatedly attempted to make the point that employment in forest industries

contributes to the well-being of northern Ontario communities. Almost all of the indicators reflect the relatively high levels of income for people employed in the forest industry compared to other industries.

Income is not the only measure of quality of life. Income levels in the forestry industries should obviously be compared after adjusting for the cost of living in the respective communities. Income levels, especially in logging, are high in part to compensate for the very high accident rate in that industry; any comparison among industries should take differences in the working conditions into account.

Industry evidence has demonstrated that productivity has increased faster than wages. When this trend is combined with the decline in employment per unit volume of wood harvested, the net result is an average decline in contribution to total community payrolls by forest industries. This trend leads northern communities into the same problem faced by the Red Queen in Alice in Wonderland; they must run faster and faster (harvest more and more wood), just to stay in the same place.

6.7. A heavy dependence of northern communities on the forest industry detracts from community stability. There is no clear relationship between community stability and patterns of forest exploitation.

One of the reasons that is often advanced for increasing or maintaining a level of forest exploitation is the supposed relationship with community stability. There are two questions that must be answered to assess this claim:

- (a) What is community stability?
- (b) What is the relationship between community stability and exploitation of the forest resource?

Bayly (1976) suggests that "[c]ommunity stability is the result of all those things that make people want to stay in the community." (p.202). A more precise definition is clearly needed, but does not appear to exist in the forestry literature. Hornberger (1974) argues that to have a stable community 25% of the total population should be employed and that a single industry should not employ more than 10% of the labour supply. On the basis of this definition, many of the single industry towns in northern Ontario are not stable and attempts to increase the level of employment in the main industries will actually detract from their stability.

Communities based on a single industry may be "...exceedingly vulnerable to market conditions, [have] no independent economic or social sustenance, and [be] obliged to be a temporary home for a transient labour force." (Marchak, 1983, p. 367). It may be that the only way that primary industries in these towns contribute to stability is that if they leave, greater instability will result.

Community stability is often cited as an outcome of even-flow regulations (a strict form of sustained yield). However, as Byron (1978) points out, short-term stability of employment or incomes cannot be achieved in this way when producing for a volatile export market. Stability of employment and incomes is also hampered by the strongly seasonal nature of logging. Under these circumstances, it is essential to ask whether community stability should be a forest policy goal, what the trade offs are in using forest policy to achieve community stability, and, in particular, whether there might not be better ways to achieve the same goals (Waggener, 1977).

6.8. Community stability is more likely to be achieved by diversification away from forest industries.

Community stability is a social goal that may be achieved in a variety of ways. Byron (1978) recommends (p.66): "...further

diversification in many directions and at many levels to reduce the vulnerability of the economy to any one fluctuating factor." Communities and regions dependent on the mining industry have also looked to diversification strategies to sustain their economies (Centre for Resource Studies, 1984), focussing on development of existing local industries (Wojciechowski, 1980). Such diversification may be possible even for towns that are heavily dependent on timber-processing. A recent study of single industry towns in Canada (Exhibit 1058) noted that:

Many single-industry communities, both those that have been hit by a closure or a cut-back, and those that feel threatened, are convinced that the diversification of their economic base is their only salvation. For some, it may be too late for this approach to restore them to their original stature, but for others, a concerted effort in this direction could prove productive. To achieve maximum success, economic diversification efforts should begin as soon as the single-industry community is born. However, even at the eleventh hour, attempts at economic diversification may prove more productive than no effort at all. Communities are aware that their diversification efforts may result in new jobs which require different skills and pay less than the jobs which were lost, as has occurred in Chemainus, British Columbia and in other communities. Nevertheless, they are prepared to ~~accept the hardships of a transition to a new work force~~ as (p.17, emphasis added).

- 6.9. A central part of Ontario's current timber management program is the Forest Production Policy. The Policy is founded on faulty economic premises and is inadequate as a basis for provincial forest use planning.

The expectation that timber harvests could increase indefinitely in the future is built into Ontario's Forest Production Policy.

In 1972, a Forest Production Policy was approved by the provincial cabinet, presumably based on a document entitled forest Production Policy Options for Ontario (Division of Forests, OMNR, 1972) [Exhibit 136]. The document laid out a set of five options for province-wide silvicultural programs with the associated harvest levels for the year 2020. The cabinet selected a future harvest level of 9.1 million cunits (25.8 million m³) per year. This value was not one of the original options, but was exactly halfway between the then present cut of 6.2 million cunits and the anticipated future cut of 12.0 million cunits (Lie, 1978).

The responsibility for meeting the provincial target has been distributed among the MNR's Regions and Districts. Since that time the implementation of the Production Policy silvicultural programs has been below scheduled levels, in part because of underfunding by the provincial government (Anonymous, 1985a). The Policy is due to be revised in the near future.

The basic projections of future demand for roundwood that underlie the Policy are simple linear extrapolations of past trends. Baskerville (1986) described it as an analysis of demand that "...would be considered trivial today." (p.64). The demand estimate is based on a 1967 projection of world demand by the FAO. As noted in the Production Policy study:

It is particularly difficult to relate these estimates of demand on Canada's forest resources to Ontario. Regional demand forecasts are obviously needed, and forecasts for individual provinces are preferred. It is rather unlikely that relative shares of both domestic and export markets will remain unchanged to the year 2020. (pp.25-26).

Market shares for Ontario-based producers have not, in fact, remained constant (Andersen and Brownright, 1985). Overall, Canada's share of international forest trade has dropped from roughly 25% to 20% over the last two decades (Boulter, 1986). In paper and paperboard, the drop was from 9.8% in 1965 to 7.7% in 1983 (Koken, 1986). In terms of market share in the United States, newsprint exports from Canada dropped from 80% in 1950 to 57% in 1984 (Canadian Pulp and Paper Association, 1985). There is no reason to believe that Ontario-based producers have been exempt from these trends.

Anderson (1979) criticized the analysis leading to the adoption of the Production Policy on two fundamental points. First, the Ontario analysis was based on the assumption that value-added by timber-processing industries represented the contribution of the additional wood to the provincial economy. This implicitly assumes that over a forest rotation, there is no mobility of labour or capital between the rest of the economy and the forest sector. This unrealistic assumption has the effect of inflating the net benefits of any regeneration program.

Anderson's second point is that the Production Policy assumes

that the net benefits of the regeneration program will be received by 2020, corresponding to a rotation period of less than fifty years from the start of the program (1972). This is much less than the ninety years or more that appears to be Ministry policy (see for example the silvicultural guides for various working groups).

6.10. A thorough analysis of demand and supply at the provincial, national, and international level for both timber and non-timber forest outputs is needed to anticipate the future demands on Ontario forests.

In order to produce the maximum net social benefits from the forest, the future values of timber and other forest services must be estimated as accurately as possible. The prediction of future values is essential to land allocation and other basic decisions in forest management.

The proper estimation of future demand for timber must take into account several key factors, including:

- i. the distribution of shipments among markets;
- ii. the growth rates of each of the markets;
- iii. the relative competitiveness and market share of

Ontario-based producers in each of those markets; and

- iv. possible sudden shifts in markets that could result from policy changes, such as the softwood lumber export tax or recycling legislation in the United States.

A similar list of factors applies to the other forest services.

The central factors which influence the future supply of timber include:

- i. the spatial distribution of economically accessible timber in relation to timber-harvesting capacity;
- ii. harvesting costs; and
- iii. the volumes, growth rates, age structure, species mix, and quality distribution of the available inventory.

A similar list of factors applies to the other services provided by forests.

A proper basis for making forest management decisions requires a careful and systematic analysis of all of the services provided by forests and of the way they interact. This analysis is essential to the goal of maximizing net social benefits from the forest.

TO FFT WITNESS STATEMENT NO. 7

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APPENDIX A

VALUATION OF NON-MARKET GOODS AND SERVICES

Estimation of net social benefits from forest management activities relies on an accurate valuation of goods and services. Market-derived monetary values may deviate from a true social value because of market institutions, externalities, advertising efforts, the management of public goods, and income distributions (Brown, 1982). The valuation of non-market goods and services from the forest presents an additional set of problems.

Hyman (1981) has reviewed a variety of methods for approximating the value of extramarket benefits and costs. He distinguishes five major classes. Economic surrogates include related expenditures, travel cost approaches, unit day values, changes in property value, and wage differentials. Supply side methods include estimating replacement costs and defensive expenditures, and estimating the cost of alternatives. Hypothetical valuation uses bidding and surveys to construct markets. Tradeoff analysis investigates the relative willingness to pay for different non-market goods or services. The last major class, threshold analysis, typically identifies the present net value that must be received from a given development to compensate for the loss of a particular set of goods or services.

The U.S. Water Resources Council (1979) has recommended three

methods for quantifying the net benefits of recreation opportunities: the contingent valuation method (CVM), the travel cost method (TCM), and unit day values. The contingent valuation method was recently reviewed by Cummings et al. (1986). It is a method based on the construction of hypothetical, or contingent, markets primarily through the use of carefully designed surveys.

Ellis and Fisher (1987) have adopted an alternative approach to estimating the value of environmental goods that is suitable in those cases where environmental goods and services are inputs to the production of marketed goods.

A review (Sorg and Loomis, 1984) of various methods for estimating amenity forest values (in particular the travel cost method and the contingent valuation method) painted an optimistic picture of the ability of the methods to produce "fairly consistent" results. It concluded that: "The differences in value that exist can be largely explained by differences in resource quality and relative location from user populations." (p.20).

Gibbs et al. (1979) estimated the value of outdoor recreation in a multiple-use context by taking explicit consideration of the timber benefits foregone by the development of a campground. They noted that the costs of providing recreation were not covered by the fees charged, a result that appears to be fairly common among such studies. Guldin (1981) took a similar approach and estimated the cost of establishing a wilderness area in terms of the foregone

timber value.

In terms of studies for specific non-timber values, a series of studies done at the Rocky Mountain Forest and Range Experiment Station in the United States has estimated the net economic value of a variety of non-timber uses of forested areas: recreational steelhead fishing (Donnelly et al., 1985), deer hunting (Donnelly and Nelson, 1986), hunting unique species (bighorn sheep, mountain goat, and antelope) (Loomis et al., 1985), elk hunting (Sorg and Nelson, 1986), waterfowl hunting (Sorg and Nelson, 1987), and upland game hunting (Young et al., 1987). Johansson et al. (1988) have approached the problem more directly and tried to assess the optimum size of a moose population.

The basic approach in such studies is to estimate the willingness to pay beyond the level of expenditures for the particular good or service. This will be a measure of consumer surplus, the correct measure of benefit to the consumer. Thus while expenditures by bird watchers in the United States totalled about \$500 million in 1975 (Cumming and Barnes, 1987), the economic benefit is measured by their willingness to pay more than this amount.

In British Columbia, a series of four studies have derived estimates of willingness to pay by non-resident hunters (Reid, 1985a), resident hunters (Reid, 1985b), freshwater anglers (Reid, 1986), and participants in non-hunting and other wildlife activities (Reid et al., 1986). In this last category, British

Columbians would have been willing to pay \$200 million annually above their expenditures (\$490 million). They would also have been willing to contribute an additional \$106 million annually "to preserve the present abundance and variety of wildlife".

There appears to be remarkably little information on the willingness to pay by hunters or fishermen in Ontario. One exception is a study conducted jointly with the federal government attempting to estimate the consumers' surplus of active resident anglers by means of survey techniques (OMNR and Department of Fisheries and Oceans, 1988). This study estimated a willingness to pay of \$490 million above expenditures. Volunteer inputs of time to improve wildlife and fish habitat reflects a willingness to pay for these viewing opportunities or fishing opportunities that is not captured by the market.

People may be willing to pay quite substantial amounts (on the order of hundreds of dollars annually) for environmental preservation or improvement (Kneese, 1985). Even in regions dependent on resource exploitation there may be significant support for wilderness areas (e.g. Utter, 1983).

The willingness to pay for quite general environmental benefits has come under increasing scrutiny by economists. A number of categories have been distinguished, e.g. option value (preserving options for the future), existence value (valuing the existence of some natural feature of the environment), and bequest value

(wishing to ensure that the benefit will be available to one's offspring). The theoretical distinctions have become increasingly well-formulated (e.g. Peterson and Sorg, 1987) and empirical studies have begun to develop reliable estimates of these values. For example, Brookshire et al. (1987) reviewed a number of studies which have attempted to estimate existence values. Rahmatian (1987) tried to identify the relative weight of four reasons for preserving the air quality in Grand Canyon National Park: user value, option value, existence value, bequest value. Brown and Daniel (1986), Daniel (1985), and Hull and Buhyoff (1986) have attempted to quantify the components of forests which lead to the perception of scenic beauty. This study has been taken further to estimate the cost of producing scenic beauty (Brown, 1987).

A consequence of placing economic values on non-timber goods and services from forests is that other economic concepts may be considered. For example, Zagata (1984) has suggested that forest companies might be able to bank wildlife habitat units and Cullen and Familton (1987) have examined the desirability of transferable recreation permits.

One of the arguments against user fees for forest-based recreation that would approximate the fees determined by market forces is that application of such fees would be inequitable. As Reiling and Anderson (1985) point out, there are already substantial barriers to use of forest recreation opportunities by low-income groups (e.g. travel costs, equipment costs).

COST BENEFIT ANALYSIS OF FOREST MANAGEMENT ON HYPOTHETICAL FOREST MANAGEMENT UNIT

TABLE 1
BASIC PARAMETERS AND DERIVED STATISTICS

LINE ITEM	ALT A	ALT B1	ALT B2	ALT C	ALT D	Source or Reference for Parameters
BASIC PARAMETERS						
1 Basic Secondary Road Cost per km	20000	20000	20000	20000	20000	Ketcheson (see Table 11) rounded
2 Basic tertiary road cost per km	8567	8567	8567	8567	8567	Wtd avg Ketcheson winter and summer (cf Table 11)
3 dimension east-west (km)	70	70	70	70	70	Assumption
4 dimension north-south (km)	70	70	70	70	70	Assumption
5 distance to mill	100	100	100	100	100	Assumption
6 Fire Protection Cost per ha	0	0.85	0.85	0.85	0.85	Provincial average
7 haulage cost per m ³ per km	0.07	0.07	0.07	0.07	0.07	Greasley (1983)
8 insect protection cost per ha	0.00	0.01	0.01	0.01	0	Provincial Grants for spraying/ha
9 logging cost per m ³	18.50	18.50	18.50	18.50	18.50	Greasley (1983)
10 percent areas of concern	3.2%	3.2%	3.2%	1.6%	1.6%	Assumption
11 percent non-forested	25.0%	25.0%	25.0%	25.0%	25.0%	Provincial average
12 percent protected	5.0%	5.0%	5.0%	5.0%	5.0%	Provincial average
13 Planting Cost per ha	0	0	0	500	0	Black Sturgeon Forest FMA agreement, rounded
14 Planting year	0	0	0	0	0	Assumption
15 Price at mill	25	25	25	25	25	CPFP quote, July 1990, rounded
16 Recreation Management Costs	50000	100000	100000	100000	100000	2 - 4 person years @ \$25,000
17 Rotation period - first harvest	0	100	100	80	80	C. Benson, personal judgement
18 Rotation Period - Subsequent harvest	0	100	100	80	200	C. Benson, personal judgement
19 Scarification Cost	0	0	0	311	0	Black Sturgeon Forest FMA
20 Scarification year	0	0	0	0	0	Benson (1988)
21 Secondary Road Cost Premium	0	0.556608	0.239224	0	0	See Table 13
22 Secondary Road density	0	0.002683	0.002683	0.002683	0.002683	Ketcheson (Table 11 below)
23 Secondary Road Development Period	0	100	100	80	80	Not used in this model
24 social discount rate	5.00%	5.00%	5.00%	5.00%	5.00%	Lower bound, Treasury Board Guidelines (1966)
25 Spray (I) Cost per ha	0	0	0	50	0	Class EA
26 Spray (I) year	0	0	0	5	0	Benson (1988)
27 Spray (II) Cost per ha	0	0	0	50	0	Class EA
28 Spray (II) year	0	0	0	15	0	Benson (1988)
29 standing yield per ha	130	130	130	130	130	Midrange Ketcheson; cf. Table 11
30 tertiary road cost premium	0	0.556608	0.239224	0	0	See Table 13
31 tertiary road density (ha/km)	0	0.03861	0.03861	0.03861	0.03861	Ketcheson (1977) Domtar Case Study
32 Visitor days (hunting/fishing)	1000	2000	2000	2000	2000	10-20 times prov. avg. for this area of Crown Land
33 Visitor days (non-cons., road access)	500	1000	1000	1000	1000	Illustrative number
34 Visitor days (Wilderness)	1000	2000	2000	2000	2000	Illustrative number
35 WTP (hunting/fishing)	25	25	25	15	20	Compare Bowes and Krutilla, Table 11 below
36 WTP (Non-Consumptive, road access)	25	25	25	10	15	Compare Bowes and Krutilla, Table 11 below
37 WTP (Wilderness)	100	25	25	20	20	Compare Bowes and Krutilla, Table 11 below
38 Subsequent yield as % of natural	0	100%	100%	150%	80%	Illustrative figures
39 Yield - subsequent rotations (m ³ /h)	0	130	130	195	104	line (38) * line (29)
DERIVED VALUES						
40 Area of FMU (ha)	490000	490000	490000	490000	490000	line (3)*line(4)/100
41 Productive Forest	367500	367500	367500	367500	367500	line (40) * (1-line(11))
42 Production Forest	337365	337365	337365	343245	343245	line (41) * (1-line (10) -line (12))
43 Discount Factor	0.952381	0.952381	0.952381	0.952381	0.952381	1 / (1+line (24))
44 Price at Roadside (\$/m ³)	18	18	18	18	18	line (15) - lines (5)*(7)

COST BENEFIT ANALYSIS OF FOREST MANAGEMENT ON HYPOTHETICAL FOREST MANAGEMENT UNIT

TABLE 2
SUMMARY OF COSTS AND BENEFITS - BASE CASE
(THOUSANDS OF 1990 DOLLARS)

LINE ITEM	ALT A	ALT B1	ALT B2	ALT C	ALT D
EVALUATED COSTS AND BENEFITS					
Timber Benefits					
1 First Harvest	0	-40755	-33377	-34692	-34692
2 Subsequent Harvests less	0	-328	-269	-79587	-2
3 Secondary Roads	-0	5916	4710	4830	4733
4 Protection	0	6637	6637	6637	6560
5 NPV of Timber Alone	0	-53636	-44992	-125746	-45987
6 NPV of Recreation	1837	525	525	-420	-105
7 NPV of Evaluated benefits	1837	-53111	-44467	-126166	-46092
8 Social Discount Rate	0.05	0.05	0.05	0.05	0.05
9 Annualized Benefits (k\$/a)	92	-2656	-2223	-6308	-2305
UNEVALUATED BENEFITS (+) AND COSTS (-) Compared to Alternative A					
Wildlife Volume	++	++	++	+	+
Wildlife Species Diversity	+	+	+	-	?
Loss of Tree Species	neutral	neutral	neutral	-	-
Loss of Old Growth	-	-	-	-	-
Even Flow of Timber	yes	yes	yes	yes	no

continued...

TABLE 2 NOTES

- Line (1) from Table 3
- Line (2) from Table 4
- Line (3) from Table 6
- Line (4) from Table 7
- Line (5) = Lines (1) + (2) - (3) - (4)
- Line (6) from Table 5
- Line (7) = line (5) + line (6)
- Line (8) from Table 1
- Line (9) = line (8) * line (9)

TABLE 3
BENEFIT OF FIRST HARVEST

LINE ITEM	ALT A	ALT B1	ALT B2	ALT C	ALT D
1 Production Forest	337365	337365	337365	343245	343245
2 Rotation Period	0	100	100	80	80
3 Standing Volume/ha	130	130	130	130	130
ANNUAL VALUES (dollar values as of 1990)					
4 Area Harvested (ha)	0	3374	3374	4291	4291
5 Volume harvested (m ³)	0	438575	438575	557773	557773
6 Price at Roadside (\$/m ³)	18	18	18	18	18
7 Value at Roadside (\$)	0	7894341	7894341	10039916	10039916
8 Logging Costs per m ³	18.5	18.5	18.5	18.5	18.5
9 Total logging costs (\$)	0	8113628	8113628	10318803	10318803
10 Tertiary Road Density (km/ha)	0.0000	0.0386	0.0386	0.0386	0.0386
11 Average Tertiary Roads Constructed	0	130	130	166	166
12 Basic Tertiary Road cost per km	8567	8567	8567	8567	8567
13 Tertiary Road Cost Premium, %	0.00%	55.66%	23.92%	0.00%	0.00%
14 Tertiary Road Cost / km	8567	13336	10617	8567	8567
15 Total Tertiary Road Costs per yea	0	1737045	1382871	1419208	1419208
16 Annual Net Benefit	0	-1956333	-1602158	-1698095	-1698095

PRESENT VALUE

17 Social Discount Rate	0.05	0.05	0.05	0.05	0.05
18 Discount Factor	0.952381	0.952381	0.952381	0.952381	0.952381
19 Present Value of Initial Harvest, Excluding Secondary Roads (k\$)	0	-40755	-33377	-34692	-34692

TABLE 3
NOTES
lines (1) (2) (3) from Table 1
line (4) = line(1)/line(2)
line (5) = line (4) * line (3)
line (6) from Table 1


```
line (7) = lines (6) * (5)
line (8) from Table (1)
line (9) = line (8) * (7)
line (10) from Table 1
line (11) = line (4) * line(10)
line (12) from Table 1
line (13) from Table A-5
line (14) = line (12) * (1 + line 13)
line (15) = line (14) * line (11)
line (16) = line (7) - (9) - (15)
lines (17) (18) from Table 1
line (19) = line (16) * (1-line(17)^(line(2)-1))/(1-line (17))/1000
```

TABLE 4
BENEFIT OF SUBSEQUENT HARVESTS

LINE ITEM	ALT A	ALT B1	ALT B2	ALT C	ALT D
NET BENEFIT PER HA PER ROTATION - VALUE AT TIME OF INITIAL HARVEST					
Silvicultural Costs:					
Scarification					
Year of Treatment	0	0	0	0	0
Cost /ha	0	0	0	311	0
PV of Cost/ha	0	0	0	311	0
Planting					
Year of Treatment	0	0	0	0	0
Cost /ha	0	0	0	500	0
PV of Cost/ha	0	0	0	500	0
Spraying (I)					
Year of Treatment	0	0	0	5	0
Cost /ha	0	0	0	50	0
PV of Cost/ha	0	0	0	39	0
Spraying (II)					
Year of Treatment	0	0	0	15	0
Cost /ha	0	0	0	50	0
PV of Cost/ha	0	0	0	24	0
Total Silviculture	0	0	0	874	0
Yield (m ³ /ha)	0	130	130	195	104
Rotation, Subsequent Harvests (a)	0	100	100	80	200
Tertiary Road Costs/ha					
Basic tertiary road cost /km	8567	8567	8567	8567	8567
Tertiary Road Cost premium/km	0	4768	2049	0	0
Total Tertiary Road Cost /km	8567	13336	10617	8567	8567
Tertiary Road Density	0.0000	0.0386	0.0386	0.0386	0.0386
Tertiary Road Cost /ha	0	515	410	331	331
PV at start of rotation	0	4	3	7	0.02

Continued...

TABLE 4 CONTINUED

22	Logging Costs / ha	18.5	18.5	18.5	18.5	18.5
23	Logging Costs (\$/ m ³)	0	2405	2405	3607.5	1924
24	Logging costs (\$/ha)	0	19	19	76	0.12
25	PV at start of rotation					
26	Value of Harvest per ha per rotation	18	18	18	18	18
27	Price at Roadside	0	2340	2340	3510	1872
28	Value of Harvest at Roadside	0	19	19	74	0.11
29	Present Value of Harvest at road					
30	(calculated from beginning of rotation)					
31	Net Benefit of Subsequent Harvests per ha per rotation (calculated at beginning of rotation)	0.00	-4.63	-3.79	-883.30	-0.02
32	NET BENEFIT OF SUBSEQUENT HARVESTS IN PERPETUITY					
33	VALUED AT TIME OF INITIAL HARVEST					
34	Net Benefit Per Ha in perpetuity	-0.00	-4.67	-3.82	-902.42	-0.02
35	Area Harvested	0	3374	3374	4291	4291
36	Net Benefit of Future Harvests	-0	-15746	-12896	-3871885	-100
37	PRESENT VALUE OF ALL SUBSEQUENT HARVESTS ON THE FMU					
38	PV of all future harvests on FMU	0	-328036	-268648	-8E+07	-2094
39	Social Discount Rate	0.05	0.05	0.05	0.05	0.05
40	Discount Factor	0.952381	0.952381	0.952381	0.952381	0.952381

line (3) = line(2)*line(34)^line(1), etc
line (13) = lines (3)+(6)+(9)+(12)
line (28) = line (27)-(13)-(21)-(24)
line (29) = line (28) * (1-line(34))^(line (15)-1)/(1-line(34))
line (30) = Table 3, line (1)
line (31) = line (29)*(30)
line (32) = line (31) / (1 - line(34)^line(13))
lines (33) (34) from Table 1

TABLE 5

RECREATION BENEFITS

- 198 -

LINE ITEM	ALT A	ALT B1	ALT B2	ALT C	ALT D
ANNUAL VALUES					
Hunting/Fishing					
1 Visitor-days	1000	2000	2000	2000	2000
2 Willingness-to-pay /day	25	25	25	15	20
3 Total WTP	25000	50000	50000	30000	40000
Non-consumptive Recreation - Road Access					
4 Visitor-days	500	1000	1000	1000	1000
5 Willingness-to-pay /day	25	25	25	10	15
6 Total WTP	12500	25000	25000	10000	15000
Non-Consumptive Recreation - Wilderness					
7 Visitor-days	1000	2000	2000	2000	2000
8 Willingness-to-pay /day	100	25	25	20	20
9 Total WTP	100000	50000	50000	40000	40000
10 Total Benefits	137500	125000	125000	80000	95000
11 Management Costs	50000	100000	100000	100000	100000
12 Net Benefit (\$)	87500	25000	25000	-20000	-5000
13 Change from (A)	0	-62500	-62500	-107500	-92500
PRESENT VALUE					
14 Social Discount Rate	5%	5%	5%	5%	5%
15 Discount Factor	0.952381	0.952381	0.952381	0.952381	0.952381
16 PV of Net Benefit (\$)	1837500	525000	525000	-420000	-105000
17 Change from (A)	0	-1312500	-1312500	-2257500	-1942500
line (3) = line(1)*(2), etc. line (10) = lines (3)+(6)+(9) line (11) from Table 1 line (11) = line (10) - (11) lines (14), (15) from Table 1 line (16) = line (12) / (1-line(15))					

TABLE 6
PRESENT VALUE OF SECONDARY ROAD COSTS

LINE ITEM	ALT A	ALT B1	ALT B2	ALT C	ALT D
1 Rotation Period, First Harvest	0	100	100	80	80
2 Subsequent Rotation (years)	0	100	100	80	200
3 Social Discount Rate	0.05	0.05	0.05	0.05	0.05
4 Discount Factor	0.952381	0.952381	0.952381	0.952381	0.952381
FIRST HARVEST, ANNUALIZED CONSTRUCTION COSTS					
5 Area Harvested (ha)	0	3374	3374	4291	4291
6 Secondary Road Density (km/ha)	0	0.002683	0.002683	0.002683	0.002683
7 Avg. Sec. Roads Constructed (km/a)	0.00	9.05	9.05	11.51	11.51
8 Basic Secondary Road Cost (\$/km)	20000	20000	20000	20000	20000
9 Secondary Road Cost Premium (%)	0.00%	55.66%	23.92%	0.00%	0.00%
10 Annualized Road Cost (\$/km)	20000	31132	24784	20000	20000
11 Total Secondary Road Costs/a	0	281828	224365	230260	230260
FIRST HARVEST, PRESENT VALUE CONSTRUCTION COSTS					
12 PV Const. Costs, first harvest	-0	5871128	4674037	4733021	4733021
PRESENT VALUE, CONSTRUCTION AND RECONSTRUCTION					
13 Road Costs in Perpetuity	-0	5916117	4709853	4830485	4733294

TABLE 6 NOTES

lines (1), (2), (3), (4) from Table 1
line (5) from Table 3, line (4)
line (6) from Table 1
line (7) = line (6) * line (5)
line (8) from Table 1
line (9) calculated in same manner as tertiary road cost premium
in Table 3 (see also Table 13)

TABLE 7
PRESENT VALUE, PROTECTION COSTS

LINE ITEM	ALT A	ALT B1	ALT B2	ALT C	ALT D
ANNUAL COSTS					
Fire Protection					
1 Productive Forest (ha)	367500	367500	367500	367500	367500
2 Fire Protection Cost per ha	0.00	0.85	0.85	0.85	0.85
3 Total cost (\$/a)	0	312375	312375	312375	312375
Insect Protection					
4 Productive Forest	367500	367500	367500	367500	367500
5 Insect Protection Cost per ha	0.00	0.01	0.01	0.01	0.00
6 Total cost (\$/a)	0	3675	3675	3675	0
7 Total Annual Costs	0	316050	316050	316050	312375
PRESENT VALUE					
8 Social discount rate	0.05	0.05	0.05	0.05	0.05
9 Discount factor	0.952381	0.952381	0.952381	0.952381	0.952381
10 PV of Annual Costs	0	6637050	6637050	6637050	6559875

TABLE 7 NOTES
 lines (1)(2)(4)(5)(8)(9) from Table 1
 line (3) = line (1)*(2) etc.
 line (7) = line (3) + (6)
 line (10) = line (7) / (1 - line(9))

TABLE 8
SENSITIVITY TESTS ON ANNUALIZED TIMBER BENEFITS (THOUSANDS OF DOLLARS)

	ALT A	ALT B1	ALT B2	ALT C	ALT D
--	-------	--------	--------	-------	-------

(a) VARIATIONS IN THE DISCOUNT RATE - WITH ALLOWABLE CUT EFFECT

Yield on subsequent rotations	0	130	130	195	104
First Rotation Period	0	100	100	80	80
Price at mill	50	50	50	50	50

Discount Rate	Annualized Timber Benefits				
1%	0	9087	9159	11165	7707
3%	0	8960	9210	8886	10953
5%	0	8831	9263	8524	12047
7%	0	8711	9319	8592	12470
9%	0	8610	9380	8755	12745
11%	0	8530	9447	8936	12988

Conclusion: The Ranking of the Projects changes with the interest rate.
Intensive management attractive only at very low discount rates

(b) VARIATIONS IN THE DISCOUNT RATE - WITHOUT ALLOWABLE CUT EFFECT

Yield on subsequent rotations	0	130	130	195	104
First Rotation Period	0	100	100	100	100
Price at mill	50	50	50	50	50

Discount Rate	Annualized Timber Benefits				
1%	0	9087	9159	9638	6882
3%	0	8960	9210	7446	9101
5%	0	8831	9263	6873	9693
7%	0	8711	9319	6837	9940
9%	0	8610	9380	6943	10136
11%	0	8530	9447	7081	10323

Conclusion: The artificial regeneration option is much less attractive without the allowable cut effect.

continued...

TABLE 8 (continued)

	ALT A	ALT B1	ALT B2	ALT C	ALT D
VARIATIONS IN PRICE AT MILL - WITH ALLOWABLE CUT EFFECT					
Yield on subsequent rotations	0	130	130	195	104
First Rotation	0	100	100	80	80
Discount Rate	5.00%	5.00%	5.00%	5.00%	5.00%
Price at Mill		Annualized Timber Benefits			
10	0	-9589	-9157	-15174	-10907
25	0	-2682	-2250	-6287	-2299
50	0	8831	9263	8524	12047
75	0	20343	20776	23336	26394
100	0	31856	32288	38147	40741

Conclusion: Intensive forestry is most attractive at high wood prices.

(d)	VARIATIONS IN PRICE AT MILL - WITHOUT ALLOWABLE CUT EFFECT				
Yield on subsequent rotations	0	130	130	195	104
First Rotation	0	100	100	100	100
Discount Rate	5.00%	5.00%	5.00%	5.00%	5.00%
Price at Mill		Annualized Timber Benefits			
10	0	-9589	-9157	-12321	-8907
25	0	-2682	-2250	-5123	-1932
50	0	8831	9263	6873	9693
75	0	20343	20776	18870	21318
100	0	31856	32288	30866	32942

Conclusion: But when the ACE is removed, the ranking of projects is not affected by the price at mill.

continued...

TABLE 8 (continued)

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(e) VARIATIONS IN NATURAL YIELD - WITH ALLOWABLE CUT EFFECT

=====

	ALT A	ALT B1	ALT B2	ALT C	ALT D
Price at mill	50	50	50	50	50
First Rotation	0	100	100	80	80
Discount Rate	5.00%	5.00%	5.00%	5.00%	5.00%
Subsequent Yield as % of Natural	0%	100%	100%	150%	80%
Natural Yield	Annualized Timber Benefits				
75	0	4057	4490	2378	6094
100	0	6227	6659	5172	8800
125	0	8397	8829	7965	11506
130	0	8831	9263	8524	12047
150	0	10567	10999	10759	14212
175	0	12736	13168	13552	16918

Conclusion: Natural regeneration techniques are preferred when site productivity is relatively low (percentage spread in yields under various management options remaining constant

(f) VARIATIONS IN NATURAL YIELD - WITHOUT ALLOWABLE CUT EFFECT

Price at mill	50	50	50	50	50
First Rotation	0	100	100	100	100
Discount Rate	5.00%	5.00%	5.00%	5.00%	5.00%
Subsequent Yield as % of Natural Yield	0%	100%	100%	150%	80%
	Annualized Timber Benefits				
75	0	4057	4490	1898	4872
100	0	6227	6659	4160	7063
125	0	8397	8829	6421	9255
130	0	8831	9263	6873	9693
150	0	10567	10999	8683	11446
175	0	12736	13168	10944	13638

Conclusion: When the ACE is removed, natural regeneration techniques dominate artificial regeneration, regardless of site productivity.

TABLE 9
GNE DEFLATOR, 1971-1990
1981=100

YEAR	INDEX
1970	40.6
1971	41.9
1972	44.3
1973	48.2
1974	55.1
1975	60.6
1976	65.8
1977	69.9
1978	74.2
1979	81.6
1980	90.2
1981	100.0
1982	108.7
1983	114.1
1984	117.7
1985	120.7
1986	123.6
1987	129.0
1988	134.3
1989	140.8

SOURCE: Cansim D20337 tabulated in
Bank of Canada Review, May 1990, S105

TABLE 10
CONVERSION FACTORS

ITEM	EQUIVALENT	SOURCE OR REFERENCE
1 foot	30.48 cm	Ketcheson, "Impact of Strip Cutting on Logging Road Costs"
1 mile	1.61 km	Ketcheson, "Impact of Strip Cutting on Logging Road Costs"
1 acre	0.4 ha	Ketcheson, "Impact of Strip Cutting on Logging Road Costs"
1 cunit	2.83 m ³	Ketcheson, "Impact of Strip Cutting on Logging Road Costs"
1 cord	3.62 m ³	Ketcheson, "Impact of Strip Cutting on Logging Road Costs"
1 ft ³	5.35 fbm	Crandall Benson
1 Mfbm	189	Alberta, Alberta L&F, "Environmental Effects of Timber Harvesting..."
1 ft ³	5.291005 fbm	Implied by above
1 cunit/acre	7.075 m ³ /ha	Calculated from above

TABLE 11
NOTES ON BASIC PARAMETER ESTIMATES

Basis of Estimate	Original Units	Converted Units
Primary and Secondary Roads constructed under Ontario Resource Access Program (OMNR, Statistics, 1987)		
Construction	30200 1987 \$/km	32962 1989 \$/km
Maintenance	430 1987 \$/km	469 1989 \$/km
Data obtained from MNR Heritage Guidelines Conference (Don Huff, 1989)		
Primary	49000 1989\$/km	49000 1989\$/km
Secondary	19000 1989\$/km	19000 1989\$/km
Ketcheson (1977, Table 2), Domtar Case Study (1977 values)		
Secondary Road Construction	15775 \$/mi	19736 1989 \$/km
Secondary Road Maintenance	0.055 \$/cunit-m	0.195 1989 \$/m ³ /km
Winter Tertiary Road Construction	4150 \$/mi	5192 1989 \$/km
Winter Tertiary Road Maintenance	100 \$/mi	125 1989 \$/km
Winter Tertiary Road Reconstruct.	1000 \$/mi	1251 1989 \$/km
Summer Tertiary Road Construction	8300 \$/mi	10384 1989 \$/km
Summer Tertiary Road Maintenance	100 \$/mi	125 1989 \$/km
Summer Tertiary Road Reconstruct.	0 \$/mi	0 1989 \$/km
Percent winter harvest	35%	35%
Secondary Road Service Area	1500 acres/mi	373 ha/km
Implied density		0.002683 km/ha
Average Maximum Skidding Distance	425 ft	130 m
Implied tertiary road separation		259 m
Implied tertiary road density		0.03861 km/ha
Available Volume		
low	10 cunits/acre	71 m ³ /ha
high	28 cunits/acre	198 m ³ /ha
Average Tertiary Road Construction		8567
OMNR, Statistics, 1987		
Average Stumpage Charge + Bonus	3.53 '86 \$/m ³	4.02 89\$/m ³
Ontario Forest Industry Statistical Reports, 1986		
Avg. price Ontario Pulpwood exports	69 '86 \$/cord	21.71 89\$/m ³
OMNR (1986) The Forest Resources of Ontario, 1986. Table 18		
Gross Total Volume of Standing Black Spruce, Age Classes 81+ (see Table 12 of this report)	175 m ³ /ha	175 m ³ /ha
Provincial Averages		
Percent Non-forested	25.00%	
Percent Areas of Concern	16.00%	
Percent Protected	5.50%	

continued...

TABLE 11 (continued)
NOTES ON BASIC PARAMETER ESTIMATES

Basis of Estimate	Original Units	Converted Units
Implied Planting Cost/ha at 1500 trees/ha		
planting container stock	279	
purchasing container stock	238	
total	517	
Greasley, Gordon. "Evaluation of Three Methods of Stumpage Determination for Thunder Bay District". Lakehead University, School of Forestry. Thesis, 1983.		
Area 1 appraisal (average wood cost /cunit - 1982?)		
felling	11.45 82\$/cunit	5.24 89 \$/m ³
skidding	11.48 82\$/cunit	5.25
slashing	5.21 82\$/cunit	2.38
loading	2.31 82\$/cunit	1.06
hauling 57 miles	9.02 82\$/cunit	4.13
road	9.00 82\$/cunit	4.12
administration	10.00 82\$/cunit	4.58
total	58.47 82\$/cunit	26.76 89 \$/m ³
haulage/cunit/mile	0.158 82\$	0.07 89 \$/m ³
total ex road and haulage	40.45 82\$/cunit	18.51 89 \$/m ³
Ontario Public Accounts, 1989, p.4-334		
Aviation and Fire Mgt.	45492 k\$	
Annual Report, MNR, 1989		
Resource Access Program		
Royalties		
stumpage	78306 k\$	
area charges	9484	
forest products	143	
fees	45	
Reimbursements		
Govt of Canada	35474	
Other	38	
Sales and Rentals	2154	
Total Ont. Revenue	125644	
Expenditures		
Forest Management	107642 k\$	
FMA's	79141	
Total Expenditure	186783	
of which		
Grants for Aerial Spraying	503985 k\$ (from Public Accounts)	
Net Cost to Taxpayer	96613 (federal and provincial)	
Total Area, Crown Forests	529660 km ²	
(from OMNR Statistics, 1988-89)		

continued.

TABLE 11 (continued)
NOTES ON BASIC PARAMETER ESTIMATES

Basis of Estimate	Original Units	Converted Units
Implied Planting Cost/ha at 1500 trees/ha		
planting container stock	279	
purchasing container stock	238	
total	517	
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Resource Access Program		
Royalties		
stumpage	78306 k\$	
area charges	9484	
forest products	143	
fees	45	
Reimbursements		
Govt of Canada	35474	
Other	38	
Sales and Rentals	2154	
Total Ont. Revenue	125644	
Expenditures		
Forest Management	107642 k\$	
FMAs	79141	
Total Expenditure	186783	
of which		
Grants for Aerial Spraying	503985 k\$ (from Public Accounts)	
Net Cost to Taxpayer	96613 (federal and provincial)	
Total Area, Crown Forests	529660 km ²	
(from OMNR Statistics, 1988-89)		

continued...

TABLE 11 (continued)
NOTES ON BASIC PARAMETER ESTIMATES

Basis of Estimate	Original Units	Converted Units
Aviation/Fire Mgmt per ha	0.858898	
Grants for Spray/ha	0.009515	
OMNR (1987) Class Environmental Assessment ...		
Average cost of aerial tending		
From EA document, p.92	50 87 \$/ha	
OMNR, Statistics 1987		
HunterDays, 1986		
Moose	11810	
Deer	36360	
Bear	7810	
Hunter Days/ha Crown Forest	0.000223	
estimated per 490000 ha FMU	109.2569	
Bowes and Krutilla (1989, p. 231)		
Willingness to Pay for Visit to White Mountain National Forest		
(1981 US \$/visit) (1 visit = 1.5 visitor days)		
(these are biased downwards due to omission of the opportunity cost of time)		
C\$/visitor-days	low	13.11 \$/visit 14.77 '89
C\$/visitor-days	high	16.46 \$/visit 18.54 '89

TABLE 12
AREA AND GROSS TOTAL VOLUME (GTV) OF THE NORTHERN REGION PRODUCTION FOREST
PLUS FOREST RESERVE, SPRUCE WORKING GROUP, BY AGE CLASS

AGE CLASS	AREA (ha)	GTV (m ³)	YIELD (m ³ /ha)
1-20	105071	1077874	10
21-40	153423	8271777	54
41-60	383125	39730806	104
61-80	624349	98449960	158
81-100	706521	1.23E+08	174
101-120	1223681	2.23E+08	182
121 +	1170818	1.98E+08	169

Age Classes 81-121+

3101020 5.43E+08

175

Source: OMNR (1986) The Forest Resources of Ontario, 1986. Table 18

TABLE 13 (continued)
ROAD COST PREMIUM

LINE	ITEM	Year	ALT B1	ALT B2	ALT C
55	Kilometres Constructed	55	0	0	1
56		56	0	0	1
57		57	0	0	1
58		58	0	0	1
59		59	0	0	1
60		60	0	0	1
61		61	0	2	1
62		62	0	2	1
63		63	0	2	1
64		64	0	2	1
65		65	0	2	1
66		66	0	2	1
67		67	3	2	1
68		68	3	2	1
69		69	3	2	1
70		70	3	2	1
71		71	3	0	1
72		72	3	0	1
73		73	3	0	1
74		74	3	0	1
75		75	3	0	1
76		76	3	0	1
77		77	3	0	1
78		78	0	0	1
79		79	0	0	1
80		80	0	0	1
81		81	0	2	1
82		82	0	2	1
83		83	0	2	1
84		84	0	2	1
85		85	0	2	1
86		86	0	2	1
87		87	0	2	1
88		88	0	2	1
89		89	0	2	1
90		90	0	2	1
91		91	0	0	1
92		92	0	0	1
93		93	0	0	1
94		94	0	0	1
95		95	0	0	1
96		96	0	0	1
97		97	0	0	1
98		98	0	0	1
99		99	0	0	1
100		100	0	0	1
					NPV
					30.90
					19.85
					Premium
					55.66%
					23.92%
					0.00%

TABLE 13
ROAD COST PREMIUM

LINE	ITEM	Year	ALT B1	ALT B2	ALT C
1	Kilometres Constructed	1	3	2	1
2		2	3	2	1
3		3	3	2	1
4		4	3	2	1
5		5	3	2	1
6		6	3	2	1
7		7	3	2	1
8		8	3	2	1
9		9	3	2	1
10		10	3	2	1
11		11	3	0	1
12		12	0	0	1
13		13	0	0	1
14		14	0	0	1
15		15	0	0	1
16		16	0	0	1
17		17	0	0	1
18		18	0	0	1
19		19	0	0	1
20		20	0	0	1
21		21	0	2	1
22		22	0	2	1
23		23	0	2	1
24		24	0	2	1
25		25	0	2	1
26		26	0	2	1
27		27	0	2	1
28		28	0	2	1
29		29	0	2	1
30		30	0	2	1
31		31	0	0	1
32		32	0	0	1
33		33	0	0	1
34		34	3	0	1
35		35	3	0	1
36		36	3	0	1
37		37	3	0	1
38		38	3	0	1
39		39	3	0	1
40		40	3	0	1
41		41	3	2	1
42		42	3	2	1
43		43	3	2	1
44		44	3	2	1
45		45	0	2	1
46		46	0	2	1
47		47	0	2	1
48		48	0	2	1
49		49	0	2	1
50		50	0	2	1
51		51	0	0	1
52		52	0	0	1
53		53	0	0	1
54		54	0	0	1

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